INSTRUCTION MANUAL

MODEL 519
S/N 16163 AND UP

FUNCTION GENERATOR

A6

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FUNCTION GENERATOR

EXACT ELECTRONICS, INC.
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EXACT ELECTRONICS, INC.
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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION 1

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

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WAVEFORMS: Sine, square, triangle, positive sine, positive pulse, negative pulse.

DYNAMIC FREQUENCY RANGE: Main generator, 1 Hz to 11 MHz (0.01 Hz in search mode) AM/FM generator, 1 Hz to 1 MHz.

MODES OF OPERATION: Run, gate, trigger, pulse, burst, FM, AM, simultaneous AM-FM, ext. carrier.

SYNC OUTPUTS:

Main generator, square wave approximately 4V P-P open circuit. Approx. 100Ω output impedance.

AM/FM generator, square wave approx. 4V P-P, 100Ω output impedance. Located on rear panel.

FREQUENCY ACCURACY:

Main generator, ±2% of frequency range. 1 Hz to 1 MHz. ±(2% of setting plus 2% of frequency range) 1 MHz to 10 MHz.

AM/FM generator, 1 Hz to 1 MHz in three calibrated steps. Accurate within ±5%. Uncalibrated continuously variable between steps: variable has 100:1 range down from calibrated step.

OUTPUTS:

1. 50Ω output impedance. All waveforms 20V P-P open circuit. 10V P-P into 50Ω with exception of Positive Sine and Positive or Negative Pulses which are 10V peak open circuit, 5V peak into 50Ω. A full 80dB of attenuation is provided in 10dB steps with 20dB continuously variable (greater than 120dB utilizing carrier level in AM mode).
2. Separate selected AM-FM output approximately 2V P-P.

GATE AND TRIGGER MODES:

Input: DC coupled, input impedance approx. 1K. Trigger and gate signal requirements, manual or external voltage of approx. 1.2V for turn on. TTL compatible.

EXTERNAL AM INPUT:

Approx. 10V P-P for 100% modulation at full output. Frequency response, 1dB down at 1 MHz.

EXTERNAL FM INPUT:

Approx. 5V P-P for Maximum deviation. Slew rate limit approximately 0.1V/μsec.

EXTERNAL CARRIER INPUT:

Approximately 10V P-P for full output.

SINE WAVEFORM DISTORTION: $< 0.5\%$ 1Hz to 100 KHz (Typically $< 0.2\%$). No harmonics. $<$ 30dB down 100 KHz to 11 MHz.

SINE FREQUENCY RESPONSE: 0.1dB to 100KHz, 2dB to 10 MHz.

SQUARE WAVEFORMS: Rise and fall < 20 nanoseconds. Overshoot and ringing <5%.

TRIANGLE LINEARITY: 99% to 100 KHz.

D.C. OFFSETS: Variable ±5V into 50Ω, ±10V open circuit. Circuit will automatically limit (clip) signal if D.C. offset plus signal exceeds maximum voltage output.

FREQUENCY STABILITY:
0.05% of setting for 10 min.
0.25% of setting for 24 hrs.

AMPLITUDE STABILITY:
0.05% of maximum P-P amplitude for 10 min.
0.25% of maximum P-P amplitude for 24 hrs.

SYMMETRY (time): ±1% + 10 nS

POWER REQUIREMENTS:
Input Voltage - 115 VAC ± 10% or 230 VAC ± 10%
Frequency - 50 to 400 Hz
Power Consumption - Approximately 20W.
Other voltages available.

PHYSICAL CHARACTERISTICS
30.5cm wide X 8.9cm high X 37.5cm deep. Weight - 5.22kg. Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

OPTION "B" - 0.1 Hz - 11 MHz, Main generator

OPTION "G" - 0.01 Hz - 1 MHz, AM/FM generator

NOTE: (unless otherwise stated). Specifications apply 10% to maximum output voltage with instruments terminated into 50 Ω and do not apply in the Search Mode or AM Mode. Specifications are valid at 25°C ± 5°C warmup time of 30 min.

VERIFICATION OF SPECIFICATIONS

Following is a list of test equipment required to validate the specifications of the Model 519 AM/FM Generator.

Test equipment with accuracy equal to the following list of test equipment will be acceptable for specification validation.

Oscilloscope, DC to 50MHz
Plug-in, Differential 20mv/cm sensitivity
Counter/Timer, .1μsec time base
DVM, .01% accuracy
Harmonic Distortion Analyzer, less than 0.1% residual distortion
Spectrum Analyzer, 1KHz to 100MHz

NOTE: Allow 60 minutes for warm-up.

FREQUENCY ACCURACY:

Main Generator:

1. Set controls as follows:

RANGE	1K
MULTIPLIER	1.0
MODE	RUN
CARRIER	TRI
ATTENUATORS	OFF (OUT)
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

2. Connect the Counter/Timer to the Sync Output jack on the front panel with an appropriate coaxial cable to the A.C. input.

3. Observe time interval on counter of 1000μsec ± 20μsec.

4. Set Range to 100. Observe time interval of 10msec ± .2msec.

5. Set Range to 10. Observe time interval of 100msec ± 2msec.

6. Set Range to 1. Observe time interval of 1000msec ± 20msec.

7. Set Multiplier to .10. Observe time interval between 8.33sec and 12.50sec.

FREQUENCY ACCURACY, Main Generator (Continued)

8. Set Range to 10. Observe time interval between 833msec and 1250msec.
9. Set Range to 100. Observe time interval between 83.3msec and 125msec.
10. Set Range to 1K. Observe time interval between 8.33msec and 12.5msec.
11. Set Range to 10K. Observe frequency of 1KHz ± 200Hz.
12. Set Range to 100K. Observe frequency of 10KHz ± 2KHz.
13. Set Range to 1M. Observe frequency of 100KHz ± 20KHz.
14. Set Range to 10M. Observe frequency of 1MHz ± 220KHz.
15. Set Multiplier to 1.0. Observe frequency of 10MHz ± 400KHz.
16. Set Range to 1M. Observe frequency of 1MHz ± 20KHz.
17. Set Range to 100K. Observe frequency of 100KHz ± 2KHz.
18. Set Range to 10K. Observe frequency of 10KHz ± .2KHz.
19. Set Range to 1K. Observe frequency of 1KHz ± 20Hz.
20. Set Multiplier to .50. Observe frequency of 500Hz ± 20Hz.
21. Set Multiplier to 1.0.

AM/FM GENERATOR

1. Connect the Counter/Timer to the AM/FM Sync Output on rear panel with an appropriate coaxial cable to the AC input.
2. Set 100:1 VAR to CAL position.
3. Set AM/FM Range to 1MHz. Observe frequency of 1MHz ± 50KHz.
4. Set AM/FM Range to 10KHz. Observe frequency of 10KHz ± 500Hz.
5. Set AM/FM Range to 100Hz. Observe period of 10ms ± .5ms.
6. Set 100:1 VAR full CCW. Observe period > 1sec.
7. Set AM/FM Range to 10KHz. Observe period > 10ms.
8. Set AM/FM Range to 1MHz. Observe frequency < 10KHz.

FREQUENCY ACCURACY, AM/FM Generator (Continued)

9. Set 100:1 VAR to CAL and AM/FM Range to 10KHz.

TIME SYMMETRY

1. Connect the Counter/Timer to the Sync output jack on the front panel.
2. Set Range to 10K.
3. Set Multiplier to 1.0.
4. Set Counter/Timer to read time interval A to B and B to A. Observe time symmetry error $< 1\%$.
5. Set Range to 1K. Observe time symmetry error $<1\%$.
6. Set Range to 100. Observe time symmetry error $<1\%$.
7. Set Range to 10. Observe time symmetry error $< 1\%$.
8. Set Range to 1. Observe time symmetry error $< 1\%$.
9. Set Multiplier to .10. Observe time symmetry error $< 1\%$.
10. Set Range to 1K.
11. Set Multiplier to 1.0.

FREQUENCY STABILITY

Observe that the frequency remains within 0.05% for 10 minutes.

SYNC OUTPUT

1. Connect oscilloscope to the Sync output on front panel with an appropriate coaxial cable.
2. Observe square wave of approximately 2V P-P open circuit.
3. Connect oscilloscope to the AM/FM Sync output on rear panel.
4. Observe Sync pulse approximately 2V P-P open circuit.

CARRIER OUTPUT

1. Set amplitude to MAX. Connect the main output to the oscilloscope with a 50Ω coaxial cable terminated into 50Ω.
2. Observe Tri > 10V P-P.

CARRIER OUTPUT (Continued)

3. Switch through square, triangle and sine waveform, observing > 10V P-P amplitude.

4. Switch to negative square, positive square, and + sine observing > 5V peak amplitude.

5. Remove 50Ω terminator and observe > 20V P-P open circuit for square, triangle and sine waveforms and > 10V peak for positive and negative square and + sine.

6. Add 50Ω terminator, set attenuator 10dB, 20dB, 30dB, 40dB, 50dB, and 60dB and observe corresponding attenuation.

7. Rotate amplitude vernier and observe another 20dB of attenuation.

8. Set amplitude to MAX, attenuator to 0dB. (out)

GATE AND TRIGGER MODES

1. Set:

MODE	GATE
START LEVEL	0

2. Monitor output with oscilloscope.

3. Apply signal at Trig input jack, increase signal and observe main generator runs at approximately 1.2V of signal.

4. Depress Manual pushbutton and observe generator runs when button is depressed.

5. Set:

MODE----------TRIGGER

Apply signal at trigger input. Increase signal and observe main generator produces one complete cycle when trigger input rises to approximately 1.2V.

6. Depress Manual pushbutton and observe one complete cycle each time the Manual pushbutton is depressed.

SINE WAVE DISTORTION

1. Set:

MODE	RUN
RANGE	10K
MULT	1.0
AMPLITUDE	MID RANGE
FUNCTION	SINE

SINE WAVE DISTORTION (Continued)

2. Connect distortion analyzer to the output, terminated into 50Ω. Measure sine distortion of < .5%, typically .3%.

3. Set Range to 100K and measure sine distortion < .5%.

4. Set Range to 10M. Connect spectrum analyzer to main output jack and measure harmonic content. Observe no harmonics < 30dB down.

SINE FREQUENCY RESPONSE

1. Set Range to 10K.

2. Connect oscilloscope to output terminated into 50Ω.

3. Observe sine wave amplitude.

4. Set Range to 100K. Observe sine amplitude drop < .1dB.

5. Set Range to 10M. Observe sine amplitude drop < 2dB.

SQUARE WAVEFORM

1. Set:

RANGE	1M
FUNCTION	SQUARE
AMPLITUDE	MAX

2. Connect output through a 50Ω coaxial cable terminated into 50Ω to the oscilloscope.

3. Observe risetime and falltime of square < 20ns at main output.

4. Observe overshoot and ringing <5% of P-P amplitude.

D.C. OFFSET

1. Set Range to 1K, amplitude vernier to MIN.

2. Rotate D.C. offset switch and observe D.C. level shift ± 5V into 50Ω.

3. Remove terminator and observe D.C. level shift ± 10V open circuit.

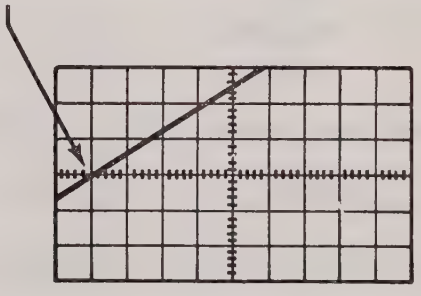
NOTE: D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

AMPLITUDE STABILITY

1. Set amplitude to MAX, D.C. offset to OFF, function to TRIANGLE.
2. Connect output through a 50Ω coaxial cable terminated into 50Ω.
3. Set plug-in sensitivity to 20mv/cm.
4. Measure accurately the positive peak of triangle and negative peak of triangle and record.
5. Wait 10 minutes and measure positive and negative peaks again. Observe amplitude change <10mv.

TRIANGLE LINEARITY

1. Connect the output to the differential plug-in through a 50Ω coaxial cable terminated into 50Ω.
2. Adjust oscilloscope to obtain one-half cycle of triangle across full horizontal grid on oscilloscope CRT.
3. Set differential plug-in sensitivity at 20mv/cm.
4. Adjust comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below:



5. Record reference voltage using DVM accurate to 1mv.
6. Adjust comparison voltage until slope of triangle intersects next major horizontal grid mark.
7. Record accurately the new reference voltage.
8. Repeat to obtain as many points as desired.

TRIANGLE LINEARITY (Continued)

9. Calculate linearity and observe linearity is 99% or better.

NOTE: Horizontal time base accuracy of oscilloscope and accuracy of DVM are important to obtain meaningful data.

SECTION 2

OPERATING INSTRUCTIONS

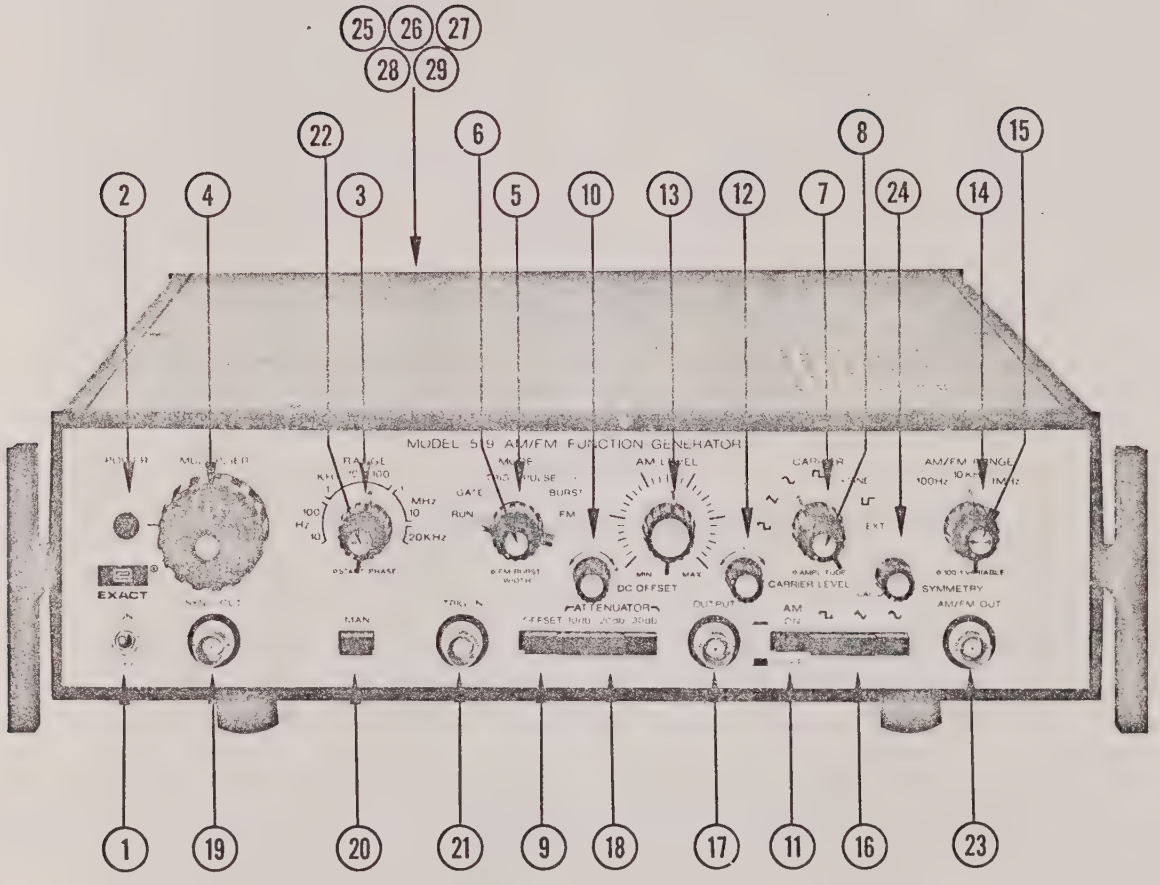


FIGURE 2.1.1.
FRONT AND REAR PANEL
FAMILIARITY

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

1. POWER ON/OFF SWITCH - Connects line voltage to the instrument.

2. PILOT LAMP - Visual indication when instrument is on.

3. RANGE SWITCH - Selects the desired range of CARRIER frequency.

4. MULTIPLIER - provides calibrated fixed steps between range settings. Each step equals 10% of range setting. The vernier dial provides variable frequency adjustment between fixed steps.

   The "S" position on the fixed step MULTIPLIER dial places the MULTIPLIER in the search mode. The search position allows the vernier dial complete control of the frequency over a three decade range.

5. MODE SWITCH - Selects the desired mode of operation.

   RUN MODE - The carrier generator will free run continuously.

   GATE MODE - The carrier generator will stop running. The generator will free run when an external signal is applied at the EXTERNAL TRIGGER INPUT or when the MANUAL PUSHBUTTON is depressed.

   TRIG MODE - The carrier generator will stop running. The generator will run for one complete cycle from an external signal or each time the MANUAL PUSHBUTTON is depressed.

   PULSE MODE - The PULSE MODE is similar to the TRIG MODE above. The AM/FM Generator will trig the carrier generator "ON" for one complete cycle at the AM/FM Generator rate.

   BURST MODE - The AM/FM Generator is connected internally to gate the carrier generator "ON" and "OFF" at the AM/FM Generator rate.

   FM MODE - The AM/FM Generator will frequency modulate the carrier generator internally when in the FM MODE.

6. FM/BURST WIDTH - Provides adjustment of the FM (sweep) width when in the FM MODE and burst width in the BURST MODE.

7. CARRIER SWITCH - Selects the desired carrier or output waveform desired. The EXT position allows the use of an external carrier or waveform.

8. AMPLITUDE - Provides > 20dB variable attenuation of the output signal. Amplitude control has no effect on carrier level or AM level adjustment.

FRONT PANEL FAMILIARITY (Figure 2.1.1) Continued

9. DC OFFSET SW - When switched on enables the variable control.

10. DC OFFSET - When switched on, provides variable control of the D.C. level of the output waveform.

11. AM SWITCH - Allows amplitude modulation of the selected carrier waveform.

12. CARRIER LEVEL - When in the AM MODE, this control provides complete adjustment of the Carrier Amplitude from Max Pos through "Null" to Max "Neg". 180° phase shift occurs from Max + to Max - setting. May be utilized as a variable phase control.

13. AM LEVEL - This control adjusts the amount of AM signal applied to the modulator. The desired amount of modulation is adjusted by means of the CARRIER LEVEL and/or the AM LEVEL controls.

14. AM/FM RANGE - Selects the desired frequency range of the AM/FM generator.

15. 100:1 VARIABLE - Provides variable adjustment of AM/FM frequency between fixed ranges. This control allows adjustment over a two decade range or 100:1.

16. AM/FM FUNCTION - A SQUARE, TRIANGLE, or SINE WAVEFORM may be selected to amplitude modulate the carrier waveform selected by the CARRIER SWITCH.

17. OUTPUT - BNC output connector providing 50Ω output impedance for connection to external equipment.

18. ATTENUATOR - A pushbutton attenuator providing a 10, 20, and 30db PAD for a total attenuation of 60db in 10db steps.

19. SYNC OUT - Provides a SQUARE WAVE for syncronizing external equipment to the Carrier Generator.

20. MANUAL PUSHBUTTON - The MANUAL PUSHBUTTON allows manual gating and triggering of the Carrier Generator in the GATE and TRIG MODE of operation.

21. EXTERNAL TRIGGER INPUT - When in the GATE and TRIG MODE, the Carrier Generator may be externally gated or triggered by application of an external signal at the EXTERNAL TRIGGER INPUT.

22. START LEVEL - When the carrier generator is in the gate, trig, pulse or burst mode of operation, the start level provides adjustment of the start phase over a ± 90° range.

23. AM/FM OUT - BNC output of selected AM/FM generator signal.

24. SYMMETRY - Control used to vary the time of the positive slope or logical portion of the selected AM/FM generator signal.

FRONT PANEL FAMILIARITY (Figure 2.1.1) Continued

25. V:f - A voltage output which is at all times proportional to the carrier frequency.

26. EXTERNAL FM INPUT - Provides external control of frequency for FM, sweeping, frequency shift keying, D.C. frequency control, etc.

27. EXTERNAL AM INPUT - When in the AM Mode, an external signal may be used to AM the Carrier Waveform selected. The AM level must be set to min. to avoid mixing of the internal and external AM signals, unless mixing is desirable.

28. EXTERNAL CARRIER INPUT - An external carrier or signal may be used when the CARRIER SWITCH is in the EXT position. Amplitude modulation of this external waveform is easily accomplished utilizing the AM/FM Generator.

29. AM/FM SYNC OUTPUT - Provides a square wave for syncronizing external equipment to the AM/FM Generator.

2.2.0 FIRST TIME OPERATION

Plug the power cord into the proper source of 117V AC or 230V AC 50-400Hz and turn on the power switch.

NOTE: It is recommended that the rear panel chassis ground and circuit ground be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

Set controls as follows:

RANGE	10K
MULTIPLIER	1.0
MODE	RUN
FUNCTION	∿
AMPLITUDE	MAX
ATTENUATOR	0dB (OFF)
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

FIRST TIME OPERATION (Continued)

1. Connect the main output through a 50Ω coaxial cable into a 50Ω terminator to a suitable oscilloscope. A 10KHz 10V P-P triangle waveform should be observed under these conditions.

2. Switch the Function switch through its various output waveforms.

3. The frequency may be selected by the Range switch and/or the Multiplier dial.

4. Switch the D.C. Offset switch ON and observe the waveform D.C. level may be adjusted as desired.

   NOTE: Reduce output amplitude while changing D.C. offset to prevent saturation of waveform.

5. Observe the output amplitude can be adjusted over its 80dB of dynamic range by the Amplitude vernier and the pushbutton attenuator.

GATE MODE

6. Place the Mode switch in the Gate position. Observe the main generator is now locked out. Observe the output while depressing the Manual pushbutton. The generator will free run as long as the pushbutton is depressed.

7. Rotate the Start Level control and observe the lockout level may be adjusted to the desired level or phase.

   NOTE: The generator will free run if the Start Level is rotated too far (90 degree phase shift).

TRIG MODE

8. Set the Main Mode switch to the Trig position. Observe one complete cycle each time the Manual pushbutton is depressed.

PULSE MODE

9. Set the Mode switch to Pulse.

   Set controls as follows:

FUNCTION	SQUARE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2ms/cm

FIRST TIME OPERATION (Continued)

Trigger scope from rear panel AM/FM Sync output.

The generator is now being triggered by the AM/FM Generator, providing a pulse output.

Observe that the carrier generator Range and Multiplier controls vary the pulse width. The repetition rate is variable by varying the AM/FM frequency.

BURST MODE

10. Place the Mode switch to Burst. The main generator is now being gated by the AM/FM Generator, producing a burst (more than one cycle) at the output.

Set the generator controls as follows:

FUNCTION	SINE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2ms/cm

Trigger the scope from AM/FM Sync output on rear panel.

Observe by adjusting the FM/Burst width and AM/FM frequency the burst "on" and "off" time may be varied. The frequency of the main generator determines the frequency of each cycle in the Burst.

FM MODE

11. In the FM Mode, the AM/FM source is connected to the FM input internally via the FM/Burst width potentiometer.

Set controls as follows:

MODE	FM
RANGE	10K
MULTIPLIER	.10
CARRIER	TRI
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	100Hz
100:1 VAR	FULL CCW (1Hz)
FM/BURST WIDTH	MID RANGE
AM/FM FUNCTION	∧∨

FIRST TIME OPERATION (Continued)

Observe the main generator triangle is being swept about the center frequency 1KHz.

Observe the FM width change while adjusting the FM/Burst width control.

Observe the FM sweep rate change while adjusting the AM/FM frequency.

AM MODE

12. Amplitude Modulation

Set controls as follows:

RANGE	100K
MULTIPLIER	1.0
CARRIER	∿
AMPLITUDE	MAX
D.C. OFFSET	OFF
MODE	RUN
AM/FM RANGE	10K
100:1 VAR	CAL
AM LEVEL	MAX
AM	ON
AM/FM FUNCTION	∿

100%:

Connect an oscilloscope to the output. Trigger the oscilloscope from the AM/FM sync output on the rear panel.

Adjust the Carrier level until 100% modulation is obtained.

Select TRI and SQ with the AM/FM Function switch and observe the carrier modulation corresponding to the waveform selected.

SUPPRESSED CARRIER

Set the AM level to min. Adjust the carrier level for a Null at the output.

AM/FM Function to ∿.

Set the AM Level to Max and observe suppressed carrier Modulation.

2.3.0 OPERATING PROCEDURE

NOTE: Regarding the Kelvin-Varley divider frequency multiplier vernier: The vernier frequency range of the Model 519 covers three decades. The upper limit of the three decades is selected by the RANGE selector. The "S" position on the outer dial of the MULTIPLIER selector switch is the "Search" position, and allows the generator to be tuned over the entire three decades of range by the inner MULTIPLIER dial. In position other than "Search", frequencies in the upper decade can be "dialed in", with the inner MULTIPLIER dial covering 0.1 of the upper decade.

RUN MODE-UNMODULATED SIGNAL OUT

A. Insure that no connections have been made to the rear panel EXTernal FM IN connector. On the front panel, one Sine, Triangle, or Square modulation waveform push button should be activated, or "in". Place all other push buttons in the "out", or de-activated position. Select RUN with the MODE selector.

B. Select the desired output, or "carrier" frequency with the RANGE and MULTIPLIER selectors. The frequency selected is available as a constant amplitude square wave at the front panel SYNC OUT connector. This signal can be used as an external sync for oscilloscope presentations, or for frequency or period measurements on a counter/timer.

C. Select Sine, Square, or Triangle output waveform desired with the CARRIER selector. The waveform selected, at the frequency selected, is available at the front panel OUTPUT connector for oscilloscope displays, counter/timer operations, etc.

D. Adjust the output AMPLITUDE control as necessary. The AMPLITUDE control will provide $\approx$20db of range, with a maximum output of $\approx$10V P-P into a 50Ω load.

E. The ATTENUATOR push buttons will provide lower output levels if necessary. The AMPLITUDE and ATTENUATOR controls affect only the signal levels at the OUTPUT connector. 80db of range is provided, with a minimum output of 1.5mv into a 50Ω load.

NOTE: 50Ω coaxial cable and termination loads must be used to avoid wave shape distortion and frequency response deterioration of the OUTPUT signal.

OUTPUT OFFSETS

A. The OFFSET controls affect only the signal present at the OUTPUT connector.

2.3.0 OPERATING PROCEDURE (Cont.)

OUTPUT OFFSETS (Cont.)

B. The DC OFFSET control is activated by activating the OFFSET push button, and will provide positive or negative DC offset reference for the waveform. The output Sine, Triangle, or Square will be symmetrical about this reference.

With the OFFSET push button de-activated, the DC reference level is zero volts.

NOTE: Sufficient range is provided in the DC OFFSET control to cause output "clipping" under some conditions. The output DC offsets and output amplitudes will be simultaneously affected by the ATTENUATOR controls.

PULSE, +SINE, AND NEGATIVE PULSE CARRIERS

A. The positive PULSE waveform, selected by the CARRIER control, will divide the Square wave amplitude by two, clamp the negative peaks to the DC reference level selected by the DC OFFSET and OFFSET controls, and produce the resultant waveform at the OUTPUT connector.

B. The +SINE position of the CARRIER selector will perform the same signal conditioning as "A" above for the Sine wave.

C. The negative PULSE, selected by the CARRIER control, will divide the Square wave amplitude by two, clamp the positive peaks to the DC reference level selected by the DC OFFSET and OFFSET controls, and produce the resultant waveform at the OUTPUT connector.

EXTERNAL FM OPERATIONS

A. The rear panel EXTernal FM connector provides external control of the main generator's output frequency. Since the input is DC coupled, DC levels can be applied to offset the carrier frequency selected by the MULTIPLIER and RANGE controls, ramp signals can be applied for frequency sweep operations, or external signals can be used to Frequency Modulate the Main Generator output.

NOTE: Signals applied to the EXTernal FM connector are routed directly to the frequency control circuitry of the main generator, and are not affected by the front panel controls. During operations other than EXTernal FM, errors may develop if connections are made to the EXTernal FM connector.

B. A 0 to +5VDC signal applied to the EXTernal FM connector will cause the main generator frequency to shift from 0.001 of range, to 1.0 of range.

C. A 0 to -5VDC signal will cause a decrease from 1.0 of range to 0.001 of range.

2.3.0 OPERATING PROCEDURE (Cont.)

MODULATION GENERATOR OPERATION

A. Connect an oscilloscope's vertical input to the AM/FM OUT connector. Sync the scope from the rear panel AM/FM SYNC OUT. Place the SYMMETRY control in the CAL position, and the 100:1 VARIABLE fully Clockwise.

B. Select the desired Sine, Triangle, or Square modulation wave shape by activating the appropriate push button, and select the desired modulation frequency with the AM/FM RANGE selector. The oscilloscope should now display the selected waveform and frequency.

C. The SYMMETRY control can now be used to increase the period of the positive slope, or positive portion in the case of the square wave, of the selected waveform.

D. The 100:1 VARIABLE can be used to decrease the modulation generator output frequency up to a factor of 100:1.

PULSE MODE - INTERNAL, MANUAL, AND EXTERNAL TRIGGERS

A. Establish a carrier generator output signal as per the Run Mode procedures.

B. Establish the desired pulse repetition rate as per the Modulation Generator operations procedures.

C. Select PULSE on the MODE selector. Connect an oscilloscope's vertical input to the main generators OUTPUT, and sync the scope from AM/FM SYNC OUT. The oscilloscope will display a single 360° wave shape preceded and followed by a DC level. The DC level represents the instantaneous DC level of a point on the waveform at which the generator is started and stopped. The DC level is present when the generator is in a condition of "Lockout". The start/stop point on the waveform is adjusted with the START PHASE control. If phase angles of greater that +90° are selected, the generator may "free run".

D. For Manual pulse operation, insure that no connections are made to the TRIGger IN connector, and select TRIGger on the MODE selector. A pulse will be generated each time the MANual push button is depressed.

E. After the manual pulse, or trigger, mode has been established, an external signal can be applied to the TRIGger IN connector. A single cycle of the selected Carrier waveform will be generated with each positive transition of the signal applied to the TRIGger INput. (Scope Sync should be changed to the front panel SYNC OUT connector.)

2.3.0 OPERATING PROCEDURES (Cont.)

BURST MODE - INTERNAL, EXTERNAL, AND MANUAL GATE

A. Perform the Pulse Mode procedures "A","B", and "C".

B. Select BURST on the MODE control. Adjust the FM/BURST WIDTH control for the desired burst width.

NOTE: If the MANual push button is depressed in this mode, the Main Generator's OUTPUT will be gated on until the push button is released.

C. Insure that no connections are made to TRIGger IN, and select GATE on the MODE control. The Main Generator is now in the Manual Gate Mode. Depress MANual for an output, and release to re-enter lockout.

D. For External Gate operations, place the generator in the Manual Gate Mode, and apply a gating signal to the TRIGger IN connector. The FM/BURST WIDTH control will have no effect on the DC gate level. (Scope Sync should be changed to SYNC OUT.)

INTERNAL FM OPERATIONS

A. Establish the desired modulation frequency as per the Modulation Generator operating procedures. Connect the oscilloscope external sync to the AM/FM SYNC OUT connector on the rear panel.

B. Establish a carrier output as per the Run Mode operating procedures. Connect the OUTPUT connectors to the vertical input of an oscilloscope.

C. Select FM on the MODE selector. The oscilloscope will display the Frequency Modulated carrier with the oscilloscope synchronized to the modulating signal. Adjust the FM/BURST WIDTH control for the desired modulation level.

NOTE: Internal and external FM operations can be performed simultaneously. Care should be taken to insure that unwanted connections have not been made to the EXTernal FM input.

AM OPERATIONS - INTERNAL AND EXTERNAL

A. Establish the desired carrier frequency and wave shape as per the Run Mode procedures. Establish the Modulation frequency and wave shape as per the Modulation Generator operating procedures.

B. Connect as oscilloscope vertical input to the front panel OUTPUT connector, and sync the scope on AM/FM SYNC OUT.

2.3.0 OPERATING PROCEDURE (Con't.)

AM OPERATIONS - INTERNAL AND EXTERNAL (Con't.)

C. Adjust AM LEVEL to MINimum, and activate the AM ON push button. Adjust the CARRIER LEVEL control for the carrier amplitude and phase desired. (For suppressed carrier operations, adjust CARRIER LEVEL for a "null"). Adjust the AM LEVEL control for the desired amount of modulation.

D. For External AM operations, adjust the AM LEVEL control to MINimum, and apply an external modulating signal, at the desired modulation level, to the EXTernal AM input on the rear panel.

NOTE: Insure that no connections are made to the EXTernal AM IN connector when EXTernal AM operations are not being performed, or errors may result.

EXTERNAL CARRIER OPERATIONS

A. Select EXTernal on the CARRIER selector switch, and apply a carrier signal to the EXTernal CARRIER IN connector on the rear panel. Only the Internal and External AM modes will operate properly, Internal and External FM modes will not apply. Turn MODE to GATE and engage AM pushbutton IN.

B. For external AM modulation of an external carrier, select EXTernal on the CARRIER selector and connect a carrier signal to the EXT CARRIER IN connector on the rear panel. Connect the modulating signal to the EXT AM IN connector, activate the AM ON push button, and adjust the AM LEVEL control to MINimum. The CARRIER LEVEL, AMPLITUDE, ATTENUATOR and OFFSET controls can be used to condition the OUTPUT signal as desired.

SECTION 3

CIRCUIT DESCRIPTION

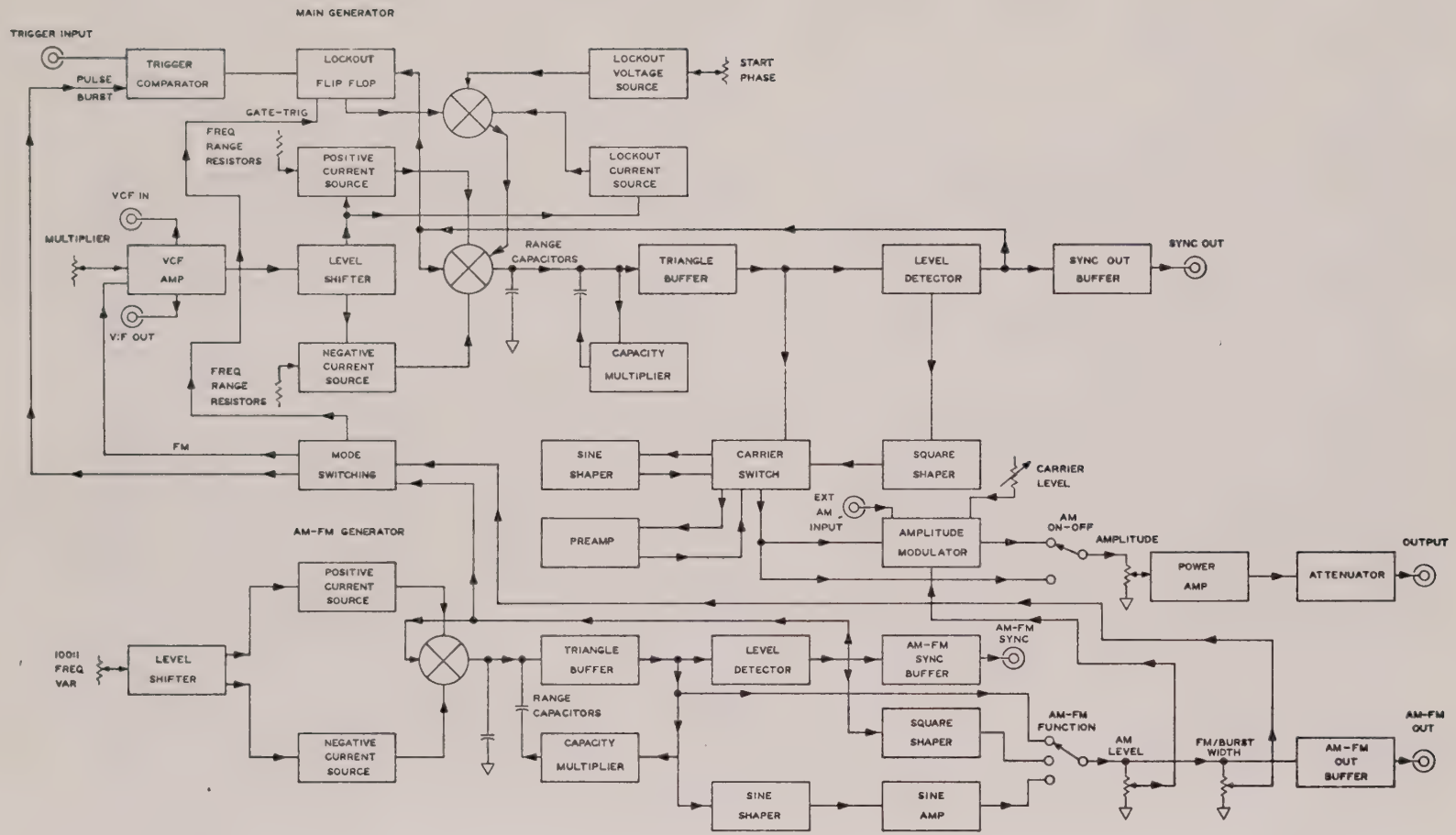


FIGURE 3.1.1.
BLOCK DIAGRAM

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

The basic generator loop utilized in this waveform generator consists of a pair of current sources alternately charging and discharging a timing capacitor. The triangular waveform generated in this timing capacitor is applied to a high input impedance triangle buffer amplifier which then applies the triangular signal to the bi-stable level detector. The output of this level detector is then fed back to alternately switch the current sources thus the loop is closed forming a free running generator. The level detector is used to switch the current sources at a predetermined point on the triangle thereby generating a constant amplitude triangle regardless of frequency of operation. Having generated a triangle of constant amplitude the frequency then is proportional to the timing capacitance and the current supplied to the capacitor from the constant current sources. Decade values of frequency are selected by decade selection of the timing capacitors and decade selection of the constant current sources. Variable frequency adjustment is accomplished by variable adjustment of the current sources through application of a DC voltage. For alternately charging and discharging the range capacitors one constant current source is a positive source and the other is a negative. In order that these can be externally controlled with a single DC voltage a pair level shifting amplifiers are supplied that convert a single input voltage to the voltages necessary to drive the positive and negative current sources. The positive and negative level shifting amplifiers are driven by the single VCF amplifier that can accept a signal either from the generator Multiplier dial or from an external DC voltage. The Multiplier dial receives its signal from a constant voltage amplifier called the VCF Amp.

This basic generator loop by nature provides a triangular waveform and a square waveform that can be processed and used as output signals to provide two waveforms. The triangular waveform can be processed through the sine shaper to provide a sinusoidal waveform. The triangular waveform available at the output of the triangle buffer can be applied directly to the preamp through the carrier switching network. This then provides the triangular output waveform. The square waveform from the level detection network is applied directly to the square amplifier which then goes through the carrier switch to the preamplifier. For sinusoidal operation the triangular waveform from the triangle buffer is supplied through the function switching network to the sine shaper. This waveform is then applied back through the function switching network to the preamplifier. The preamplifier utilized in this generator is used to boost the operating signal levels generated by the basic generator loop to something suitable for processing in the power amplifier. The preamp is also used to provide the offset sine wave which decreases the amplitude of the generated waveform to one-half and offsets it to a value that maintains one peak at 0 volts. The output of this preamp is applied directly to the amplitude potentiometer which selects the amplitude applied to the power amplifier. The power amplifier can accept not only this amplitude signal but offset signals from the external input or the variable offset control. The output of the power amplifier is directly applied to the step attenuator which can attenuate the signal in fixed db steps. The output of the attenuator is the main output connector for the generator. There are eight power supplies in this generator, four of them being the unregulated raw supplies available directly at the filter capacitors. This voltage is a nominal 30 volts which is stepped down through the positive regulators for a plus 20 volt supply and a minus 20 volt supply. The plus and minus 20 volt supplies are used to provide

3.1.0 BLOCK DIAGRAM (Continued)

voltage for the constant current sources as well as for the power amplifier. The plus and minus 20 volt raw supplies are regulated through the plus and minus 15 volt regulators to provide all the operating potentials necessary for operation of the other circuitry.

In order to lock out the main generator loop the application of the positive or negative current source for charging the timing capacitor is interrupted through the use of switching diodes and a Lock Out current source. The lock out current source is used to sink the timing current available from the positive or negative current sources and clamp the timing capacitor voltage to the Lockout Voltage source. The lock out current source derives its tracking signal from the positive level shifters in the main generator loop. This allows them to operate at a current that tracks at 2 times the current supplied by the positive and negative current sources. This prevents a lock out level shift for a change in generator frequency dial. In order that the generator can be made to always complete its last cycle of operation or complete the final portion of its cycle a lock out flip flop is used so that the application of the lock out current sources only occurs at the proper time. Operation of this flip flop is arranged such that any input or set signal will override the reset signal and a continuous application of the set signal will yield a continuous output such that the generator will run continuously. In order that both single cycle and a gated mode of operation can be realized, the mode switch selects whether the Run command can be coupled through in a DC form or AC coupled such that a single pulse is provided for each input command. The main run command overrides all others and provides for free running operation through activation of this flip flop. In order to condition the external input signals for gated and triggered operation a trigger comparator is used. The trigger comparator circuit is wired as a Schmitt trigger with appropriate feedback such that a reasonable amount of hysteresis is gained. This hysteresis provides for reliable triggering for both single shot and gated operation. The Manual trigger button will also apply the DC voltage necessary at the trigger comparator to initiate gate or trigger.

The trigger amplifier receives its input from the mode switching which selects whether the main generator is triggered from an externally applied trigger signal or from the internal AM-FM generator. This AM-FM generator is used to generate the Variable Symmetry ramp waveform used for frequency sweeping, for burst operation or amplitude modulation. For operation in the sweep mode the ramp voltage generated in the ramp generator is applied through the FM-Burst width control to the VCF Amp. An extra amplifier called the V:f amplifier is provided to monitor the voltage at the output of the VCF amplifier so that a voltage proportional to frequency is available.

The AM-FM generator utilized a basic generator loop very similar to the main generator. It uses alternate current sources charging and discharging the timing capacitors. A very high input impedance buffer amplifier is used to apply this signal then to the external loads for the ramp voltage and to the ramp level detector which is a bi-stable switch that controls the peak voltages of the waveform. The output then of this level detector is fed back to the current switch which selects either the positive current source or the negative current source. This connection closes the loop and provides a free running generator. Frequency changes are realized by changing the value of the range capacitors in 100:1 steps. Current Sources are

3.1.0 BLOCK DIAGRAM (Continued)

also controlled by a DC voltage that makes it continuously variable over a 100:1 range. This voltage is generated through the Level Shift Amplifier. The 100:1 Variable directly applies a voltage to the Level Shift Amplifier such that the voltage is proportional to frequency. The AM-FM generator also has a sine shaper and sine amplifier to produce any of the sine, square or triangle waveforms with Variable Symmetry. This can be used for AM, FM or Burst operation.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

The primary power for this instrument is supplied through the line cord to fuse F-100 which is selected for each voltage of operation. The primary power is then applied through the main power switch S-100 to different taps on the primary for different line voltages. Transformer T-100 steps down the operating potentials of the input primary power so that the proper voltage is developed through the usage of diode bridge D-100 - 103 and filter capacitors C-100 and C-110. This full wave center tapped bridge rectifier setup provides both positive and negative operating potentials of sufficient magnitude to be regulated through the usage of the plus and minus 15 volt regulators. Integrated circuit Q-120 has a self contained voltage reference and error amplifier. The output of this error amplifier is fed to series pass transistors Q-100 and Q-110 which enhances the current carrying capability of Q-120. Resistors R-102 and R-112 are current sensing resistors that allow Q-120 to reduce the output voltage of the supplies in the event the current reaches a predetermined value. The voltage feedback, necessary for the error amplifier, is enhanced through the usage of the voltage divider R-126 through R-127. The potentiometer R-126 and R-127 provide for a vernier adjustment in the power supply voltages. Diodes D-124 and D-125 are used to prevent accidental application of reverse voltages to the regulators. Capacitors C-102 and C-112 prevent the build up of transient voltages at the output of the supplies under varying load conditions. The instrument power indicator D-104 is operated from the regulated 15 volt supply. The second secondary winding is applied to the full wave bridge rectifiers D-132 and D-135. The resultant potentials are filtered by C-130 and C-170 to produce the nominal plus and minus 30 volts unregulated. Transistor Q-140 is used as a constant current source for the two series zener diodes D-130 and D-131. This reference potential from the zeners is sued directly as the base drive for the series pass transistor Q-130. Transistor Q-150 is used as a clamp amplifier to provide short circuit current limiting. If the voltage across the sensing resistor R-131 reaches a sufficient level to cause Q-150 to conduct the base drive to Q-130 is reduced accordingly by its clamping action. The -20 volt regulator is simply a mirror image of the +20 volt regulator where Q-180 is the constant current source, Q-160 is the clamp and Q-170 is the series pass transistor.

3.2.2 MAIN GENERATOR - FREQUENCY CONTROL (Figure 6.2.2)

The main generator frequency control can be from any of three signals. It can be an external voltage, an internal signal from the frequency multiplier or an internal signal from the AM-FM generator. The VCF Amp, Q-220C, is the summing point for any of these signals. Q-220A is used as a constant voltage reference for the main frequency dial. Q-220C is the VCF Summing

3.2.2 MAIN GENERATOR - FREQUENCY CONTROL (Figure 6.2.2) Continued

Amp and is used in conjunction with Q-210 as a level shifting network. Q-220D accepts this output and in conjunction with Q-230 does another level shift so that the signals at pin 3 of Q-310 and Q-280 are tracking signals of equal and opposite polarity and referenced to either plus or minus 15 volts. The voltage at pin 3 of Q-280 should vary between +10 and +15 volts and the voltage at pin 3 of Q-310 should vary between -10 and -15 volts over the full range of frequency control. Q-280 is used in conjunction with Q-260A and Q-260B to provide two positive current mode outputs one for the main timing and one for the lock out. Q-270 is a common base buffer amplifier. Q-310 is used in conjunction with Q-300 to provide a negative current mode output for the main timing. Q-290 is a common base buffer amp for this output. Q-1000 in conjunction with Q1010 is used as a variable voltage supply so that the triangle waveform developed at R-276 can be clamped through the diodes D-1000 - D1003 to a variable level. D-1004 and D-1005 accept the run, gate, and trigger commands from the lock out circuitry. D-270 and D-277 accept the square wave signal from the level detector circuit.

3.2.3 MAIN GENERATOR LOOP AND SINE SHAPER (Figure 6.2.3)

The alternate positive or negative current sources from Schematic 2 are applied to decade step values of capacitance through S-300D to produce decade frequency ranges. For very low frequency ranges the triangular waveform is amplified by Q-345 and Q-341 to produce a capacitance multiplication. Q-320 and Q-330 are used as a complimentary emitter follower buffer amplifier for this signal. Q-360A and Q-350A are used as a high impedance amplifier to buffer the triangle waveform for the level detector, sine shaper, and the pre-amplifier. Q-400A and Q-400B, a differential amplifier, is used to compare the triangle waveform peaks with a constant amplitude square waveform developed across R-402 by D-450 through D-453 and their current source resistors. Q-410 is a constant current source for Q-400A and B. Q-440 and Q-450, another differential amplifier, are used to provide high level square waveforms for positive feedback to make the level detector bistable and to provide the switching waveform for the timing current sources. These square waveforms are also used for resetting the lockout circuitry and driving the square switch for square output waveforms. The diode networks D-500 through D-520 also accept a triangle waveform from the triangle buffer. The transfer ratio of this network is non-linear and produces a sinusoidal waveform output from the triangle input.

3.2.4 LOCKOUT CIRCUITRY (Figure 6.2.4)

The lockout circuitry consists of a trigger comparator and a set reset flip flop. Integrated circuit Q-900 is connected as a high gain differential amplifier which accepts the trigger input signals at Q-900B. This signal is further amplified by Q-900C and D and applied to Q-910 and Q-920. Q-910 provides a high level output while Q-920 provides positive feedback to Q-900C creating hysteresis. Q-900E is used as a constant current source for the input amplifier Q-900B and A. The processed gate or trigger signal is then applied to the flip flop through a buffer amp Q-940. Q-950 accepts the input to the flip flop and Q-960 - Q-990 provides the positive feedback. Q-980 provides the output to control the clamp diodes for the lockout current sources.

3.2.5 MAIN GENERATOR SIGNAL CONDITIONING CIRCUITS (Figure 6.2.5)

The square wave signal from the main generator loop is applied differentially to transistors Q-700 and Q-710. These transistors drive a high level signal to the diode switching bridge D-707 - D-709. This bridge has an output that is selected by the carrier switch to be bipolar, positive or negative. The resultant square signal is then buffered through the complimentary buffer Q-720 and Q-730 for application to the power amplifier.

Transistors Q-760 and Q-770 provide the buffering amplification for the sync output signal.

The sine and triangle signals from the main generator loop and sine shaper are applied through S-500B to the preamplifier input transistors Q-530A and B. The preamplifier is a closed loop operational type with complimentary output buffers Q-580 - 590. Resistors R-583 and R-535 are the gain sealing resistors. The signal from the output of the preamplifier is then fed to the output amplifier.

3.2.6 OUTPUT AMPLIFIER (Figure 6.2.6)

The output amplifier is also a closed loop operational type amplifier where IC Q-800 is the low frequency and DC input channel. For higher frequencies the input is directly coupled to Q-820 and Q-840. The low frequency channel is a high gain input due to the use of two differential stages. Q-820 and Q-830 are a cascode connected amplifier and Q-840 and Q-850 are also a cascode connected amplifier. The output of these two complimentary stages is connected to the complimentary Darlington amplifiers Q-860 - Q-890. The output from the amplifier is extracted through R-882 - 884 which provide the series 50Ω output impedance. S-810B, C, D are used to switch the constant impedance attenuator circuitry.

3.2.7 AMPLITUDE MODULATION CIRCUITS (Figure 6.2.7)

The amplitude modulation circuitry uses the variable transconductance type of four quadrant multiplication. The modulation inputs from external or internal are applied to Q-1600 operational amplifier. This amp scales gain and DC so that these signals can be used by the level shifter. The level shifter conditions the AM signals for direct use by the variable transconductance element Q-1640. The carrier signal from the main generator is accepted by another level shifter Q1630A and B. The resultant signal is then directly applied to the variable transconductance element.

The resultant multiplied signal is then applied directly to the booster operational amplifier. Integrated circuit Q-1650 is the low frequency channel of this amplifier and the high frequency signals flow directly into the cascode pairs Q-1660 - 1670 and Q-1665 - 1675. The output from the booster amp is taken directly from the complimentary Darlington stages Q-1680 - 1690.

3.2.8 AM-FM GENERATOR (Figure 6.2.8)

The AM-FM Generator is a sine, square, triangle generator completely independent of the main generator. Q-1500 is a level shifting amplifier that drives directly into the positive and negative current source inputs. Q-1505 and Q-1510 are operational current sources

3.2.8 AM-FM GENERATOR (Figure 6.2.8)

used to alternately charge and discharge the timing capacitors Q-1530A and Q1535 comprise the high impedance triangle buffer. The triangle output from this buffer is fed directly to the level detector at pin 2 of the integrated circuit Q-1535. The output of this differential amplifier is fed to another differential amp Q-1540 and Q-1545. The positive feedback occurs through D-1515 - 1518, a diode switching network creating a bistable level detector. The square wave output from the collector of Q-1540 is also fed to the current sources to alternately switch to opposing polarities creating the triangle waveform. The triangle waveform is also applied to the non-linear network of D-1550 - 1573. The resultant sine wave output is amplified by IC-1560. Q-1545 and Q-1550 comprise the AM-FM sync out buffer amp while Q-1570 and Q-1580 comprise the AM-FM output waveform buffer.

SECTION 4

CALIBRATION

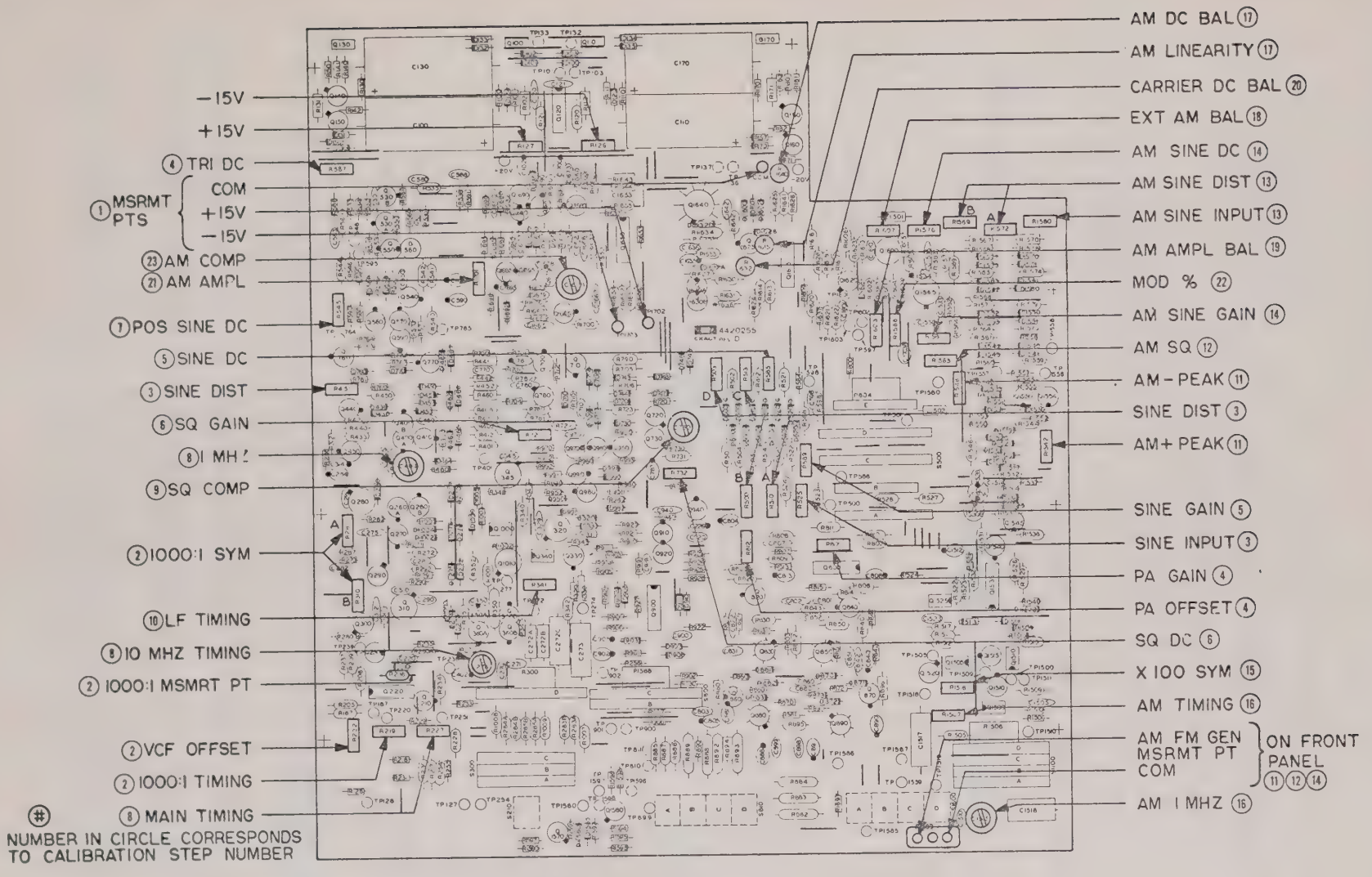


FIGURE 4.0.1
ADJUSTMENT LOCATION DETAIL

4.0 CALIBRATION PROCEDURE (Fig. 3.0.1)

Equipment required for complete Calibration.

Digital Voltmeter, Datatech Model 40 or equivalent.
Frequency Counter, Hewlett-Packard Model 5326B or equivalent.
Distortion Analyzer, Hewlett-Packard Model 333A or equivalent.
Oscilloscope, Tektronix Model 7704 with 7A13 Plug-in and X10 probe.

4.0.1 Preliminary control settings for calibration.

The instrument should be operated for a minimum of thirty minutes with the covers in place before calibration is attempted.

POWER SWITCH	ON
MULTIPLIER	S-X FULLY CW
RANGE	~~10KHz~~ 100
MODE	RUN
AM LEVEL	MAX CCW
CARRIER	TRIANGLE
AM/FM RANGE	10KHz
START PHASE	MID RANGE
FM/BURST WIDTH	FULLY CCW
AMPLITUDE	FULLY CW MAXIMUM
100:1 VARIABLE	FULLY CW
DC OFFSET	DEACTIVATED
CARRIER LEVEL	MID RANGE
AM/FM SYMMETRY	CAL
OFFSET	DEACTIVATED
ATTENUATORS	DEACTIVATED
AM	OFF
AM/FM FUNCTION	TRIANGLE

1. Connect the oscilloscope to the output connector using a 50 ohm terminator. Connect the sync out to the frequency counter.

A. Using the DVM, probe the +15V measurement point and adjust the +15V ADJ for +15.00 volts ± 0.01 volts.

B. Probe the -15V measurement point and adjust the 15V ADJ for -15.00 volts ± 0.01 volts.

2. Probe the center pin of the Ext FM input connector and adjust the VCF OFFSET ADJ for a DVM reading of 0 volts ± 0.001 volts or less.

A. Set the Multiplier to S-0. Probe the 1000:1 measurement point and adjust the 1000:1 TIMING ADJ for a reading of 0.0045 volts ± 0.5 millivolts.

2. (Cont.)
   B. Switch the carrier to square and observe the waveform on the oscilloscope. Set the scope time base for 1 millisecond per division and adjust the 1000:1 SYMMETRY ADJ A and B for a time symmetrical square wave of 5 divisions for each half cycle.

3. Set the MULTIPLIER to 1.0.
   A. Set the RANGE to 1KHz.
   B. Set CARRIER to SINE.
   C. Connect the output to the distortion analyzer and adjust the SINE DISTORTION ADJ for minimum sine distortion.
   D. Adjust the SINE INPUT ADJ for minimum distortion.
   E. Adjust the SINE DIST ADJ A,B,C,D for minimum sine distortion.
   F. Interaction may require re-adjusting the sine distortion adjustments.

4. Set the CARRIER to TRIANGLE.
   A. Set the AMPLITUDE to FULLY CCW (min).
   B. Observe the waveform on the oscilloscope and adjust the P.A. OFFSET ADJ for a waveform DC component of 0 volts ± 0.10 volts.
   C. Set the AMPLITUDE to FULL CW (max).
   D. Adjust the AMPLITUDE and DC OFFSET of the triangle waveform using the TRIANGLE D.C. ADJ and the P.A. GAIN ADJ for ±5.00 volts -0 +0.10 volts.

5. Set the CARRIER to SINE and adjust the amplitude and DC balance of the sine waveform using the SINE GAIN ADJ and the SINE DC ADJ for 5.00 -0 +0.10 volts.

6. Set the CARRIER to POSITIVE PULSE.
   A. Adjust the SQUARE D.C. ADJ so that the negative excursion of the waveform is 0 volts ± 0.10 volts.
   B. Set the CARRIER to SQUARE and adjust the SQUARE GAIN ADJ for 10.00 volts P-P +0.10 -0 volts.

7. Set the CARRIER to PLUS SINE.
   A. Adjust the POS SINE ADJ for the most negative excursion of the waveform to 0 volts ± 0.100 volts.

8. Set the CARRIER to SINE and check to see that the range is still set for 1KHz.
   A. Using the frequency counter connected to the SYNC OUT adjust the MAIN TIMING ADJ for a frequency of 1.00KHz ± 20 Hz.
   B. Check the 10KHz and the 100KHz ranges to see that the timing error is less than 2% of range. You may need to re-adjust the MAIN TIMING ADJ to minimize error for those ranges.
   C. Set RANGE to 1MHz. Adjust the 1MHz ADJ for an output frequency of 1.00MHz ± 20 KHz.
   D. Set RANGE to 10MHz. Adjust the 10MHz ADJ for an output frequency of 10.00 MHz ± 200KHz.

9. Set CARRIER to SQUARE and connect the output to the oscilloscope. Adjust the SQUARE COMPENSATION ADJ for minimum ringing and overshoot.

10. Set RANGE to 100Hz and adjust the L.F. TIMING ADJ for a frequency counter reading of 100Hz ± 2Hz.
   A. Check the 10 Hz range for 10 Hz ± 0.2 Hz. It may be necessary to re-adjust the L.F. TIMING ADJ so that both ranges meet timing specification.

11. Set MODE to GATE.
   A. Set the AM/FM RANGE to 10 KHz. The symmetry control should still be at Max CCW and the 100L1 variable should be max CW.
   B. Set the AM/FM WAVEFORM to TRIANGLE.
   C. Set the AM SWITCH to OFF.
   D. Connect the oscilloscope with the times ten probe to the AM/FM measurement point. Adjust the AM plus peak and the AM minus peak for a triangle waveform of ± 1.00 volts peak ± 0.01 volts.

12. Set the AM/FM WAVEFORM to SQUARE and adjust the AM SQUARE ADJ for a square wave of 2.00 volts P-P ± 0.10 volts.

13. Set the AM/FM WAVEFORM to SINE and connect the AM/FM output to the distortion analyzer using the coaxial cable without the terminator.
   A. Adjust the AM SINE INPUT ADJ and the AM SINE DISTORTION ADJ A and B for minimum distortion.

14. Using the oscilloscope still connected to the AM/FM measurement point adjust the AM SINE GAIN ADJ and the AM SINE D.C. ADJ for a sine wave of ± 1.00 volts peak ± 0.010 volts.

15. Connect the frequency counter to the AM FM SYNC OUTPUT.
   A. Set the counter to read period and rotate the 100:1 variable for a reading of approximately 10 milliseconds.
   B. Set the counter to measure time interval A-B and adjust the time symmetry using the X100 SYMMETRY ADJ.

16. Set the 100:1 FULL CW.
   A. Set the frequency counter to measure period and adjust the AM TIMING ADJ for 100 microseconds ± 5 microseconds.
   B. Set the AM/FM range to 100 Hz and check the frequency accuracy. It may be necessary to re-adjust the timing adjustment so that both ranges meet specifications.
   C. Set the counter to read frequency.
   D. Set the AM/FM range to 1 MHz and adjust the AM 1 MHz ADJ for 1 MHz ± 50 KHz.

17. Connect the oscilloscope to the output with the terminator.
   A. Set the RANGE to 1 KHz.

17. (Cont.)
B. Set the MODE to RUN.
C. Set the AM/FM WAVEFORM to SINE.
D. Set the CARRIER to SINE.
E. Set the AM LEVEL to Minimum (CCW).
F. Set the AM SWITCH to ON.

G. The AM LINEARITY ADJ will normally not have to be adjusted. It is a factory only adjust and should be set to mid range as near as possible, if problems are encountered. This will allow complete calibration.
H. Rotate the carrier level pot for minimum output, as viewed on the oscilloscope.
I. Adjust the AM D.C. BAL ADJ for a D.C. LEVEL of zero ± 0.10 volts.

18. Connect the DVM to the center pin of the external AM input. Adjust the EXTERNAL AM BAL ADJ for 0 volts ± 0.010 volts.

19. Connect the output to the distortion analyzer with the terminated coaxial cable. Using the voltmeter mode to measure the levels, rotate the carrier level control to both MAX CW and MAX CCW and adjust the AM AMPLITUDE BAL ADJ so that the same amplitude is read for each setting of the carrier level pot.

20. Connect the output back to the oscilloscope and adjust the CARRIER D.C. BAL ADJ so that the D.C. level of the output is the same for each setting of the carrier level pot, both MAX CW and CCW.

21. Set the carrier level to MAX CCW and adjust the AM AMPLITUDE ADJ for 10.00 volts P-P ± 0.25 volts.

22. Rotate the carrier level pot for minimum output and rotate the AM level pot for MAX CW. Adjust the MODULATION PERCENT ADJ for an output of 10.00 volts P-P ± 0.25 volts.

23. Set the AM LEVEL to MIN (CCW) and the RANGE to 1 MHz.
A. Set the CARRIER to TRIANGLE.
B. Using the oscilloscope, adjust the AM COMP ADJ for best obtainable triangle waveform.

SECTION 5

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidistat Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Ordill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Inc
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vaceline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co	San Fernando, Calif.
03508	G.E., Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Amow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Arizona
04732	Filtron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Moto Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metrogo Itan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst./Co.	Penacook, N.H.
06751	U.S. Semicor Div. of Nucleor Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co, West Div.	Van Nuys, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitron Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07968	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co., Phoenix Div.	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Bobcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electra Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09864	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10597	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11870	Metals, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell-Dubilier El. Corp.	So. Plainfield, N.J.
14936	Williams Mfg. Co.	San Jose, Calif.
15103	Wooster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Dover Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Da Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
.19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21749	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
22446	General Electric Co.	Schenectady, N.Y.
24455	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33113	GE Receiving Tube Dept.	Owensboro, Ky.
33434	Lectron, Inc.	Chicago, Ill.
36.98	Stanwyck Corp.	Hawkesburn, Ontario, Ca.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40923	Miniature Precision Bearings	Keene, N.H.
42.91	Mutor Co.	Chicago, Illinois
42990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52390	Rowan Controller Co.	Baltimore, Md.
53763	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Snaltcraft Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56289	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56737	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inst.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Ossoso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc	New York, N.Y.
65092	West Inst./Div. Daystrom	Newark, N.J.
66295	Wiltek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Alimatal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic Inaia Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Barden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	New Corning corp.	Midland, Mich.
72092	E. el-McCullough, Inc.	San aruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Williamantic, Conn.
71707	Coto Coil, Co., Inc.	Provicence, R.I.
72354	John E Fost and Company	Chicago, Illinois
726.9	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Illinois
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73078	H. M. Harper Co.	Chicago, Illinois
73138	Heilpor, Div. Beckman Instruments, Inc.	Fullerton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Phillips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carring Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. H. Winns and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knight Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
758-8	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76003	Lord Mfg. Co.	Erie, Pa.
762 0	C.W. Marwedel	San Francisco, Calif.
76433	Micamaid Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co	Cleveland, Ohio
76834	Oak Manufacturing Co.	Crystal Lake, Illinois
7768	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
7722	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Phoenix Manufacturing Co.	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rushercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78243	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Vemco Mfg. Co	Newtonville, Mass.
79124	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro, Div., Robershaw Fulton Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhasive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Graybill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co.	Norwalk, Conn.
81349	Military Specifications	.....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Prrducts	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electra Corp.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Glessner Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Torzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R.M. Bracamonte and Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco
87664	Von Wolters and Rogers, Inc.	Seattle, Wash.
87930	Tcmer Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88720	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89731	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoor, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
9 345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Rolio Materials Co.	Chicago, Illinois
91506	August Brothers', Inc.	Antioerro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gremor Mfg Co., Inc.	Wakefield, Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Fuente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinnatite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93610	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Mnnmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94644	Raytheon Mfg. Co., Industrial Comp. Div, Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94648	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95073	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Cail Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordon Corp.	Blomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Illinois
95712	Doge Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovax	Olean, N.Y.
96256	Thordarson-Meissner, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Corad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div, Controls Co. of America	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc	Boston, Mass
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
C0100	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0102	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0103	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0110	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0112	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0120	CAPACITOR, 1500 PF DISCAP	2830012	91418
C0121	CAPACITOR, 1500 PF DISCAP	2830012	91418
C0130	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0170	CAPACITOR, 1000 MFD 75 VOLT	2900053	10597
C0220	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0226	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0270	CAPACITOR, 56PF	2810561	853
C0271	CAPACITOR, 56PF	2810561	853
C0272	CAPACITOR, TIMING SET	2950012	10597
C0273	CAPACITOR, 1MF 100V	2900065	10597
C0275	CAPACITOR, 0.1 UF DISCAP	2830002	56289
C0276	CAPACITOR, 5.5-18PF TRIM	2810011	72982
C0280	TO		
C0282	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0284	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0290	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0310	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0312	CAPACITOR, 0.1 UF DISCAP	2830002	56289
C0314	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0329	CAPACITOR, 0 01 UF DISCAP	2830005	91418
C0345	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0350	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0402	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0404	CAPACITOR, 5.5-18PF TRIM	2810011	72982
C0405	CAPACITOR, 47PF MICA	2810532	853
C0450	CAPACITOR, 10PF MICA	2810529	853
C0530	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C0550	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0580	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0583	CAPACITOR, 3PF MICA	2810500	853
C0588	CAPACITOR, 18PF MICA	2810552	14655
C0590	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0598	CAPACITOR, 10PF MICA	2810529	853
C0700	CAPACITOR, 22PF MICA	2810530	853
C0710	CAPACITOR, 22PF MICA	2810530	853
C0730	CAPACITOR, 8-50PF TRIM	2810022	72982
C0780	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C0781	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0787	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0801	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0802	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0803	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0804	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0805	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0806	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0807	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0813	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0822	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0831	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0840	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0842	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0851	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0852	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0860	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0880	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0881	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0888	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0890	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0891	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0898	CAPACITOR, 2PF MICA	2810542	10597
C0899	CAPACITOR, 2PF MICA	2810542	10597
C0900	CAPACITOR, 47PF MICA	2810532	853
C0902	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0905	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0919	CAPACITOR, 10PF MICA	2810529	853
C0920	CAPACITOR, 22PF MICA	2810530	853
C0926	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C0940	CAPACITOR, 0.05 UF DISCAP	2830010	91418
C0970	CAPACITOR, 10PF MICA	2810529	853
D0100	TO		
D0103	DIODE, 1N4001	1524001	1295
D0104	LED, MLED650	1520002	4713
D0124	TO		
D0125	DIODE, 1N4001	1524001	1295
D0130	DIODE, 1N5241	1525241	4713
D0131	DIODE, 1N5241	1525241	4713
D0132	TO		
D0135	DIODE, 1N4001	1524001	1295
D0150	TO		
D0151	DIODE, 1N4001	1524001	1295
D0170	DIODE, 1N5241	1525241	4713
D0171	DIODE, 1N5241	1525241	4713
D0270	DIODE, 1N914	1520914	7910
D0271	DIODE, HOT CARRIER	1522835	10597
D0272	DIODE, HOT CARRIER	1522835	10597
D0273	DIODE, 1N914	1520914	7910
D0274	DIODE, HOT CARRIER	1522835	10597
D0275	DIODE, 1N914	1520914	7910
D0276	DIODE, 1N914	1520914	7910
D0277	DIODE, HOT CARRIER	1522835	10597
D0280	DIODE, 1N756	1520756	1295
D0310	DIODE, 1N756	1520756	1295
D0320	DIODE, 1N914	1520914	7910
D0330	DIODE, 1N914	1520914	7910
D0430	TO		
D0431	DIODE, HOT CARRIER	1522835	10597
D0450	TO		
D0453	DIODE, HOT CARRIER	1522835	10597
D0460	DIODE, HOT CARRIER	1522835	10597
D0461	TO		
D0463	DIODE, 1N914	1520914	7910
D0464	DIODE, HOT CARRIER	1522835	10597
D0465	TO		
D0467	DIODE, 1N914	1520914	7910
D0560	DIODE, 1N914	1520914	7910
D0580	DIODE, 1N914	1520914	7910
D0707	DIODE, HOT CARRIER	1522835	10597
D0709	DIODE, HOT CARRIER	1522835	10597
D0720	DIODE, 1N914	1520914	7910
D0730	DIODE, 1N914	1520914	7910
D0760	DIODE, 1N914	1520914	7910
D0770	DIODE, 1N914	1520914	7910
D0780	DIODE, 1N914	1520914	7910
D0860	TO		
D0863	DIODE, 1N914	1520914	7910
D0870	TO		
D0873	DIODE, 1N914	1520914	7910
D0900	DIODE, 1N914	1520914	7910
D0901	DIODE, 1N914	1520914	7910
D0903	DIODE, 1N914	1520914	7910
D0904	DIODE, 1N914	1520914	7910
D0905	DIODE, 1N914	1520914	7910
D0980	TO		
D0982	DIODE, 1N914	1520914	7910
D0990	DIODE, 1N914	1520914	7910
D0991	DIODE, 1N914	1520914	7910
D1001	TO		
D1002	DIODE, 1N914	1520914	7910
D1003	DIODE, HOT CARRIER	1522835	10597
D1004	DIODE, 1N914	1520914	7910
D1005	DIODE, HOT CARRIER	1522835	10597
D0744	DIODE, HOT CARRIER	1522835	10597
D0747	DIODE, 1N914	1520914	7910
D0745	DIODE, 1N757	1520757	1295
D0746	DIODE, 1N757	1520757	1295
D0748	DIODE, 1N914	1520914	7910
D0743	DIODE, HOT CARRIER	1522835	10597
F0100	FUSE, 3AG 1A SB	1590022	71400
L0400	TO		
L0402	BEAD, FERRITE G303	1140034	1121
L0580	BEAD, FERRITE G303	1140034	1121
L0570	BEAD, FERRITE G303	1140034	1121
L0700	BEAD, FERRITE G303	1140034	1121
L0710	BEAD, FERRITE G303	1140034	1121
L0595	BEAD, FERRITE G303	1140034	1121
L0860	BEAD, FERRITE G303	1140034	1121
Q0100	TRANSISTOR, 2N4918	1564918	4713
Q0110	TRANSISTOR, 2N4921	1564921	4713
Q0120	INTEGRATED CIRCUIT, SG4501	1584502	10597
Q0130	TRANSISTOR, 2N4921	1564921	4713
Q0140	TRANSISTOR, 2N2905	1562905	1295
Q0150	TRANSISTOR, 2N2219	1562219	1295
Q0160	TRANSISTOR, 2N2905	1562905	1295
Q0170	TRANSISTOR, 2N4918	1564918	4713
Q0180	TRANSISTOR, 2N2219	1562219	1295
Q0210	TRANSISTOR, 2N4250	1564250	7263
Q0220	QUAD OP AMP, LM324	1580324	10597
Q0230	TRANSISTOR, 2N5485	1565485	4713
Q0260	TRANSISTOR, MATCHED 2N4250	1574250	10597
Q0270	TRANSISTOR, 2N4250	1564250	7263
Q0280	OP AMP, CA3130	1583130	2735
Q0290	TRANSISTOR, EN2484	1562484	7263
Q0300	TRANSISTOR, EN2484	1562484	7263
Q0310	OP AMP, CA3130	1583130	2735
Q0320	TRANSISTOR, 2N2219	1562219	1295
Q0330	TRANSISTOR, 2N4121	1564121	7263
Q0340	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0345	OP AMP, CA3130	1583130	2735
Q0350	TRANSISTORS, MATCHED PAIR MPS3646	1570008	10597
Q0360	TRANSISTORS, MATCHED 2N5485	1575485	10597
Q0400	TRANSISTORS, MATCHED TIS87	1570087	10597
Q0410	TRANSISTOR, TIS87	1560087	1295
Q0440	TRANSISTOR, 2N4258	1564258	7263
Q0450	TRANSISTOR, 2N4258	1564258	7263
Q0530	TRANSISTORS, MATCHED MPS3563	1573563	10597
Q0540	TRANSISTOR, MPS3646	1563646	4713
Q0550	TRANSISTOR, 2N4258	1564258	7263
Q0560	TRANSISTOR, 2N4258	1564258	7263
Q0570	TRANSISTOR, TIS87	1560087	1295
Q0580	TRANSISTOR, TIS87	1560087	1295
Q0590	TRANSISTOR, 2N4121	1564121	7263
Q0700	TRANSISTOR, MPS3563	1563563	4713
Q0710	TRANSISTOR, MPS3563	1563563	4713
Q0720	TRANSISTOR, 2N2905	1562905	1295
Q0730	TRANSISTOR, 2N2219	1562219	1295
Q0760	TRANSISTOR, MPS3646	1563646	4713
Q0770	TRANSISTOR, 2N4121	1564121	7263
Q0870	TRANSISTOR, 2N2219	1562219	1295
Q0800	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q0820	TRANSISTOR, 2N4258	1564258	7263
Q0830	TRANSISTOR, 2N2905	1562905	1295
Q0840	TRANSISTOR, MPS3646	1563646	4713
Q0850	TRANSISTOR, 2N2905	1562905	1295
Q0860	TRANSISTOR, TIS87	1560087	1295
Q0870	TRANSISTOR, 2N4121	1564121	7263
Q0880	TRANSISTOR, 2N2219	1562219	1295
Q0900	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q0910	TRANSISTOR, 2N4121	1564121	7263
Q0920	TRANSISTOR, 2N4121	1564121	7263
Q0940	TRANSISTOR, 2N4121	1564121	7263
Q0950	TRANSISTOR, 2N4121	1564121	7263
Q0960	TRANSISTOR, 2N4121	1564121	7263
Q0970	TRANSISTOR, 2N4121	1564121	7263
Q0980	TRANSISTOR, MPS3646	1563646	4713
Q0990	TRANSISTOR, MPS3646	1563646	4713
Q1000	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1010	TRANSISTOR, 2N2905	1562905	1295
R0100	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0101	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750	1121

PART	DESCRIPTION	EXACT NO	MFG
R0102	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010	1121
R0110	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0111	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750	1121
R0112	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010	1121
R0120	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0121	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0126	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0127	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0128	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0130	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0131	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0140	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0141	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0142	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0150	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0160	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0170	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0171	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0180	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R0181	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0182	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0187	RESISTOR, 2610 OHM 1/4W 1% METAL FILM	3132611	7115
R0205	RESISTOR, 14000 OHM 1/4W 1% METAL FILM	3131402	7115
R0206	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0200	TO		
R0212	RESISTOR, 1400 OHM 1/4W 1% METAL FILM	3131401	7115
R0217	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0218	RESISTOR, 9100K OHM 1/4W 5% CARBON	3070915	1121
R0219	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0227	POTENTIOMETER, 250 OHM	3110145	71450
R0228	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0229	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R0230	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500	7115
R0231	RESISTOR, 2000K OHM 1/4W 5% CARBON	3070205	1121
R0232	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0233	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0234	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0235	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0236	TO		
R0237	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0239	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0240	TO		
R0251	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000	7115
R0253	RESISTOR, SELECTED VALUE		
R0254	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0256	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0271	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R0272	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0276	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0280	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0281	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0282	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R0283	RESISTOR, 4990 OHM MATCHED PAIR	3124991	10597
R0284	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0285	RESISTOR, 10000 OHM MATCHED PAIR	3121002	10597
R0286	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0287	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0290	TO		
R0291	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R0292	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0310	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0311	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R0312	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0320	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0330	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0331	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R0340	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0341	POTENTIOMETER, 250 OHM	3110145	71450
R0342	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531	7115
R0343	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911	1121
R0345	TO		
R0346	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0347	RESISTOR, 82K OHM 1/4W 5% CARBON	3070823	1121
R0351	RESISTOR, 301 OHM 1/4W 1% METAL FILM	3133010	7115
R0255	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0256	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0352	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499	7115
R0400	TO		
R0401	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0402	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0410	RESISTOR, 8250 OHM 1/4W 1% METAL FILM	3138251	7115
R0411	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0421	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531	7115
R0433	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531	7115
R0440	RESISTOR, 220 OHM 1/2W 5% CARBON	3010221	1121
R0441	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R0442	RESISTOR, 130 OHM 1/4W 5% CARBON	3070131	1121
R0450	RESISTOR, 2610 OHM 1/4W 1% METAL FILM	3132611	7115
R0451	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0452	RESISTOR, 2800 OHM 1/4W 1% METAL FILM	3132801	7115
R0453	RESISTOR, 130 OHM 1/4W 5% CARBON	3070131	1121
R0460	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R0500	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0501	TO		
R0502	RESISTOR, 13000 OHM 1/4W 1% METAL FILM	3131302	7115
R0503	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0504	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0510	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0513	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0514	RESISTOR, 392 OHM 1/4W 1% METAL FILM	3133920	7115
R0520	TO		
R0521	RESISTOR, 21000 OHM 1/4W 1% METAL FILM	3132102	7115
R0522	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0523	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499	7115
R0524	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0525	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0526	RESISTOR, 88.7 OHM 1/4W 1% METAL FILM	3130887	7115

PART	DESCRIPTION	EXACT NO	MFG
R0527	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0530	TO		
R0531	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0532	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180	1121
R0533	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0534	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0535	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0536	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0537	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0538	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0540	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0541	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0542	RESISTOR, 1330 OHM 1/4W 1% METAL FILM	3131331	7115
R0545	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0544	RESISTOR, 4320 OHM 1/4W 1% METAL FILM	3134321	7115
R0546	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0550	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0551	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R0560	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0561	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0570	RESISTOR, 200 OHM 1/4W 5% CARBON	3070201	1121
R0571	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0580	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0581	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0583	RESISTOR, 590 OHM 1/4W 1% METAL FILM	3135900	7115
R0584	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563	1121
R0585	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0586	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563	1121
R0587	POTENTIOMETER, 50K OHM PC TRIM	3110133	78488
R0588	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0591	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0589	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0590	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0598	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0700	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0701	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0702	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R0703	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0704	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0705	RESISTOR, 1910 OHM 1/4W 1% METAL FILM	3131911	7115
R0706	RESISTOR, 1910 OHM 1/4W 1% METAL FILM	3131911	7115
R0710	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0712	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0720	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0730	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0721	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0723	RESISTOR, 4870 OHM 1/4W 1% METAL FILM	3134871	7115
R0722	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020	7115
R0731	RESISTOR, 4320 OHM 1/4W 1% METAL FILM	3134321	7115
R0732	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0760	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0761	TO		
R0762	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0763	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0764	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0770	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0780	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0781	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0782	RESISTOR, 9090 OHM 1/4W 1% METAL FILM	3139091	7115
R0790	RESISTOR, 1370 OHM 1/4W 1% METAL FILM	3131371	7115
R0800	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0801	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0802	RESISTOR, 174 OHM 1/4W 1% METAL FILM	3131740	7115
R0803	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0805	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R0806	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0807	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0808	TO		
R0809	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R0810	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500	7115
R0811	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R0812	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0813	RESISTOR, 2700 OHM 1/4W 5% CARBON	3070272	1121
R0814	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0815	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0820	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0821	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0822	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330	1121
R0830	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060	7115
R0831	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0840	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0841	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750	1121
R0842	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0843	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0850	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060	7115
R0851	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0852	RESISTOR, 7150 OHM 1/4W 1% METAL FILM	3137151	7115
R0860	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0870	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R0872	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
R0880	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047	1121
R0882	TO		
R0884	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0885	TO		
R0886	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0887	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3130348	7115
R0888	TO		
R0889	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R0890	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R0891	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R0892	TO		
R0893	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R0895	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0896	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047	1121
R0899	POTENTIOMETER, 10K OHM MIN	3110327	71450
R0900	RESISTOR, 100K OHM 1/4W 5% CARBON	3070104	1121
R0901	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121

PART	DESCRIPTION	EXACT NO	MFG
R0902	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R0903	RESISTOR, 1800 OHM 1/4W 5% CARBON	3070182	1121
R0904	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0905	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242	1121
R0906	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332	1121
R0907	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R0908	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0910	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R0911	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0912	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0919	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0920	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0921	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R0922	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392	1121
R0923	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R0924	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301	1121
R0925	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R0926	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392	1121
R0927	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391	1121
R0930	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682	1121
R0940	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0942	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0950	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0951	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0952	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0960	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0970	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0972	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0980	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R0990	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391	1121
R0991	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0992	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R0993	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152	1121
R1001	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R1002	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R1003	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R1007	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R1008	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R1009	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
S0100	SWITCH, TOGGLE SPDT	2600103	100005
S0210	SWITCH, MAN	2600387	10597
S0240	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0300	SWITCH, RANGE	2600380	10597
S0800	SWITCH, MODE	2600391	10597
S0810	SWITCH, ATTEN	2600385	10597
S1100	SWITCH, RAMP RANGE	2600383	10597
T0100	TRANSFORMER, POWER	1200057	10597
C1501	CHOKE, 22 MICROHENRY	1140045	99848
C1502	CHOKE, 22 MICROHENRY	1140045	99848
C1528	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1512	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1505	CAPACITOR, 0.01 UF DISCAP	2830005	91418
R1501	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
Q1500	OPERATIONAL AMPLIFIER, UA741	1580010	7263
R1505	RESISTOR, 1690 OHM 1/4W 1% METAL FILM	3131691	7115
R1507	POTENTIOMETER, 1K OHM TRIM	3110147	71450
Q1510	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1501	TRANSISTOR, 2N4250	1564250	7263
R1509	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1520	POTENTIOMETER, 50K	3110339	10597
R1510	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
Q1515	TRANSISTOR, 2N4250	1564250	7263
R1515	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
D1510	DIODE, HOT CARRIER	1522835	10597
D1511	DIODE, HOT CARRIER	1522835	10597
D1513	DIODE, HOT CARRIER	1522835	10597
D1507	DIODE, HOT CARRIER	1522835	10597
Q1520	TRANSISTOR, EN2484	1562484	7263
Q1505	OPERATIONAL AMPLIFIER, UA741	1580010	7263
R1516	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R1512	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R1511	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
C1515	CAPACITOR, 8-50PF TRIM	2810022	72982
C1510	CAPACITOR, 39PF MICA	2810531	853
R1514	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
C1514	CAPACITOR, 10PF MICA	2810529	853
Q1530	TRANSISTORS, MATCHED 2N5485	1575485	10597
D1532	DIODE, 1N5241	1525241	4713
Q1535	INTEGRATED CIRCUIT, CA3046	1580043	1295
R1521	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1529	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115
R1526	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420	7115
Q1525	OPERATIONAL AMPLIFIER, UA741	1580010	7263
C1523	CAPACITOR, 1000 PF DISCAP	2830000	91418
R1524	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911	1121
R1522	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3134951	7115
C1517	CAPACITOR, 0.1MFD 100V	2900021	84411
C1516	CAPACITOR, 0.01MFD 600V	2900019	37942
R1530	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R1531	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1532	RESISTOR, 1540 OHM 1/4W 1% METAL FILM	3131541	7115
D1526	DIODE, 1N914	1520914	7910
D1525	DIODE, 1N914	1520914	7910
R1540	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
Q1545	TRANSISTOR, 2N4258	1564258	7263
R1538	RESISTOR, 287 OHM 1/4W 1% METAL FILM	3132870	7115
Q1540	TRANSISTOR, 2N4258	1564258	7263
R1537	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302	1121
R1535	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
D1515	DIODE, 1N914	1520914	7910
D1517	DIODE, 1N914	1520914	7910
R1544	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R1542	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1546	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111	7115
R1548	POTENTIOMETER, 1K OHM TRIM	3110147	71450
D1518	DIODE, 1N914	1520914	7910
D1516	DIODE, 1N914	1520914	7910

PART	DESCRIPTION	EXACT NO	MFG
R1550	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
D1519	DIODE, 1N914	1520914	7910
D1520	DIODE, 1N914	1520914	7910
D1521	DIODE, 1N914	1520914	7910
D1522	DIODE, 1N914	1520914	7910
D1523	DIODE, 1N914	1520914	7910
D1524	DIODE, 1N914	1520914	7910
R1551	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
D1531	DIODE, 1N914	1520914	7910
Q1550	TRANSISTOR, 2N4121	1564121	7263
R1553	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1555	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1554	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1552	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
D1530	DIODE, 1N914	1520914	7910
R1557	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
D1543	DIODE, 1N914	1520914	7910
R1560	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
D1542	DIODE, 1N914	1520914	7910
D1540	DIODE, 1N914	1520914	7910
R1559	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
D1541	DIODE, 1N914	1520914	7910
R1561	RESISTOR, 274 OHM 1/4W 1% METAL FILM	3132740	7115
R1563	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1558	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R1580	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1578	RESISTOR, 28.7 OHM 1/8W 1% METAL FILM	3180287	7115
R1589	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1584	RESISTOR, 63.4 OHM 1/4W 1% METAL FILM	3130634	7115
R1568	RESISTOR, 75.0 OHM 1/4W 1% METAL FILM	3130750	7115
D1570	TO		
D1573	DIODES, MATCHED SET 1N914	1530914	10597
R1570	RESISTOR, 6190 OHM 1/4W 1% METAL FILM	3136191	7115
R1572	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1567	RESISTOR, 6190 OHM 1/4W 1% METAL FILM	3136191	7115
R1569	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1566	RESISTOR, 232 OHM 1/4W 1% METAL FILM	3132320	7115
D1560	DIODES, MATCHED SET 1N914	1530914	10597
R1563	DIODE, 1N914	1520914	7910
R1574	RESISTOR, 9090 OHM 1/4W 1% METAL FILM	3139091	7115
R1565	RESISTOR, 9090 OHM 1/4W 1% METAL FILM	3139091	7115
R1571	RESISTOR, 28.7 OHM 1/8W 1% METAL FILM	3180287	7115
D1550	TO		
D1553	DIODES, MATCHED SET 1N914	1530914	10597
R1575	RESISTOR, 12700 OHM 1/4W 1% METAL FILM	3131272	7115
R1564	RESISTOR, 12700 OHM 1/4W 1% METAL FILM	3131272	7115
R1577	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1583	RESISTOR, 150K OHM 1/4W 1% METAL FILM	3131503	7115
R1576	POTENTIOMETER, 100K OHM TRIM	3110143	71450
C1534	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1535	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C1530	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C1533	CAPACITOR, 18PF MICA	2810552	14655
R1581	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1582	RESISTOR, 2800 OHM 1/4W 1% METAL FILM	3132801	7115
R1589	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
D1580	DIODE, 1N914	1520914	7910
R1591	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
Q1570	TRANSISTOR, 2N2219	1562219	1295
R1590	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R1597	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1595	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R1594	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
Q1580	TRANSISTOR, 2N2905	1562905	1295
R1598	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1593	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R1592	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
D1585	DIODE, 1N914	1520914	7910
R1596	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1585	POTENTIOMETER, 1K OHM	3110107	44655
R1586	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R1600	POTENTIOMETER, 10K OHM MIN	3110327	71450
R1609	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1605	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1607	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R1608	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R1606	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R1602	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1601	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
C1601	CAPACITOR, 0.05 UF DISCAP	2830010	91418
R1604	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R1603	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R1610	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
C1610	CAPACITOR, 22PF MICA	2810530	853
R1616	RESISTOR, 634 OHM 1/4W 1% METAL FILM	3136340	7115
Q1615	INTEGRATED CIRCUIT, CA3046	1580043	1295
R1613	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R1615	POTENTIOMETER, 100 OHM SUBMIN	3110136	80294
R1614	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R1624	RESISTOR, 14000 OHM 1/4W 1% METAL FILM	3131402	7115
R1619	RESISTOR, 909 OHM 1/4W 1% METAL FILM	3139090	7115
R1620	RESISTOR, 2800 OHM 1/4W 1% METAL FILM	3132801	7115
R1617	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
Q1620	TRANSISTOR, EN2484	1562484	7263
R1618	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1628	RESISTOR, SELECTED VALUE		
R1621	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R1623	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
D1621	DIODE, 1N914	1520914	7910
R1622	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R1642	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499	7115
C1642	CAPACITOR, 180PF MICA	2810554	853
D1600	DIODE, 1N914	1520914	7910
D1601	DIODE, 1N914	1520914	7910
D1602	DIODE, 1N914	1520914	7910
R1641	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R1640	POTENTIOMETER, 500 OHM PC TRIM	3110090	80294

PART	DESCRIPTION	EXACT NO	MFG
R1643	RESISTOR, 1650 OHM 1/4W 1% METAL FILM	3131651	7115
R1644	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
Q1630	TRANSISTOR, MATCHED 2N4121	1574121	10597
R1630	RESISTOR, 1150 OHM 1/4W 1% METAL FILM	3131151	7115
R1631	RESISTOR, 1150 OHM 1/4W 1% METAL FILM	3131151	7115
R1632	POTENTIOMETER, 500 OHM PC TRIM	3110090	80294
Q1625	TRANSISTOR, 2N4121	1564121	7263
R1631	RESISTOR, 1130 OHM 1/4W 1% METAL FILM	3131131	7115
R1625	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
D1626	DIODE, 1N914	1520914	7910
R1626	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R1627	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
D1632	MATCHED DIODES, 1N914	1530003	10597
R1633	RESISTOR, 24.3 OHM 1/8W 1% METAL FILM	3180243	7115
R1634	RESISTOR, 24.3 OHM 1/8W 1% METAL FILM	3180243	7115
R1635	RESISTOR, 931 OHM 1/4W 1% METAL FILM	3139310	7115
C1635	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
C1636	CAPACITOR, 390PF MICA	2810556	853
R1636	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R1637	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R1650	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1654	RESISTOR, 14300 OHM 1/4W 1% METAL FILM	3131432	7115
Q1650	INTEGRATED CIRCUIT, CA3046	1580043	1295
R1655	RESISTOR, 1050 OHM 1/4W 1% METAL FILM	3131051	7115
R1651	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
C1653	CAPACITOR, 0.47MFD 75V	2900050	56289
R1653	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150	1121
R1652	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R1656	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1637	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
Q1660	TRANSISTOR, 2N4258	1564258	7263
R1660	RESISTOR, 180 OHM 1/4W 5% CARBON	3070181	1121
C1660	CAPACITOR, 0.05 UF DISCAP	2830010	91418
L1660	BEAD, FERRITE G303	1140034	1121
R1662	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1663	RESISTOR, 9310 OHM 1/4W 1% METAL FILM	3139311	7115
C1662	CAPACITOR, 0.01 UF DISCAP	2830005	91418
C1667	CAPACITOR, 0.01 UF DISCAP	2830005	91418
Q1665	TRANSISTOR, MPS3563	1563563	4713
R1667	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1665	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
C1665	CAPACITOR, 0.05 UF DISCAP	2830010	91418
Q1675	TRANSISTOR, MPS3563	1563563	4713
C1666	CAPACITOR, 0.05 UF DISCAP	2830010	91418
Q1670	TRANSISTOR, 2N4258	1564258	7263
L1665	BEAD, FERRITE G303	1140034	1121
R1670	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R1673	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
C1673	CAPACITOR, 1000 PF DISCAP	2830000	91418

PART	DESCRIPTION	EXACT NO	MFG
C1676	CAPACITOR, 3-12PF TRIM	2810036	72982
C1678	CAPACITOR, 3PF MICA	2810500	853
R1696	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R1697	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
C1695	BEAD, FERRITE G303	1140034	1121
C1677	CAPACITOR, 0.05 UF DISCAP	2830010	91418
R1671	RESISTOR, 5490 OHM 1/4W 1% METAL FILM	3135491	7115
R1676	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R1677	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
C1679	CAPACITOR, 1000 PF DISCAP	2830000	91418
D1675	DIODE, 1N914	1520914	7910
D1676	DIODE, 1N914	1520914	7910
R1672	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
D1671	DIODE, 1N914	1520914	7910
D1670	DIODE, 1N914	1520914	7910
Q1680	TRANSISTOR, MPS3563	1563563	4713
C1680	BEAD, FERRITE G303	1140034	1121
R1680	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
D1660	DIODE, 1N914	1520914	7910
R1681	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
D1685	DIODE, 1N914	1520914	7910
C1680	CAPACITOR, 0.05 UF DISCAP	2830010	91418
R1685	RESISTOR, 27 OHM 1/4W 5% CARBON	3070270	1121
Q1695	TRANSISTOR, 2N4258	1564258	7263
C1695	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
D1695	DIODE, 1N753A	1520753	1295
Q1685	TRANSISTOR, 2N4258	1564258	7263
R1695	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1690	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
Q1690	TRANSISTOR, MPS3563	1563563	4713
C1690	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
D1690	DIODE, 1N753A	1520753	1295
C1700	CAPACITOR, 6.8 MFD 35 VOLT	2900043	100002
R1701	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1700	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
J0764	CONNECTOR, BNC	1310047	91836
J0900	CONNECTOR, BNC	1310047	91836
J0810	CONNECTOR, BNC	1310047	91836
J1596	CONNECTOR, BNC	1310047	91836
J0239	CONNECTOR, BNC	1310047	91836
J0217	CONNECTOR, BNC	1310047	91836
J1603	CONNECTOR, BNC	1310047	91836
J0598	CONNECTOR, BNC	1310047	91836
J1557	CONNECTOR, BNC	1310047	91836
R0599	RESISTOR, 47K OHM 1/4W 5% CARBON	3070473	1121
R0887	RESISTOR, 3.16 OHM 1/8W 1% DEP. CARBON	3193160	7115

SECTION 6

PARTS OVERLAY

AND

SCHEMATICS

FOREWORD TO SCHEMATICS

To facilitate quick refe:ence to inter-connections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexogonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection.

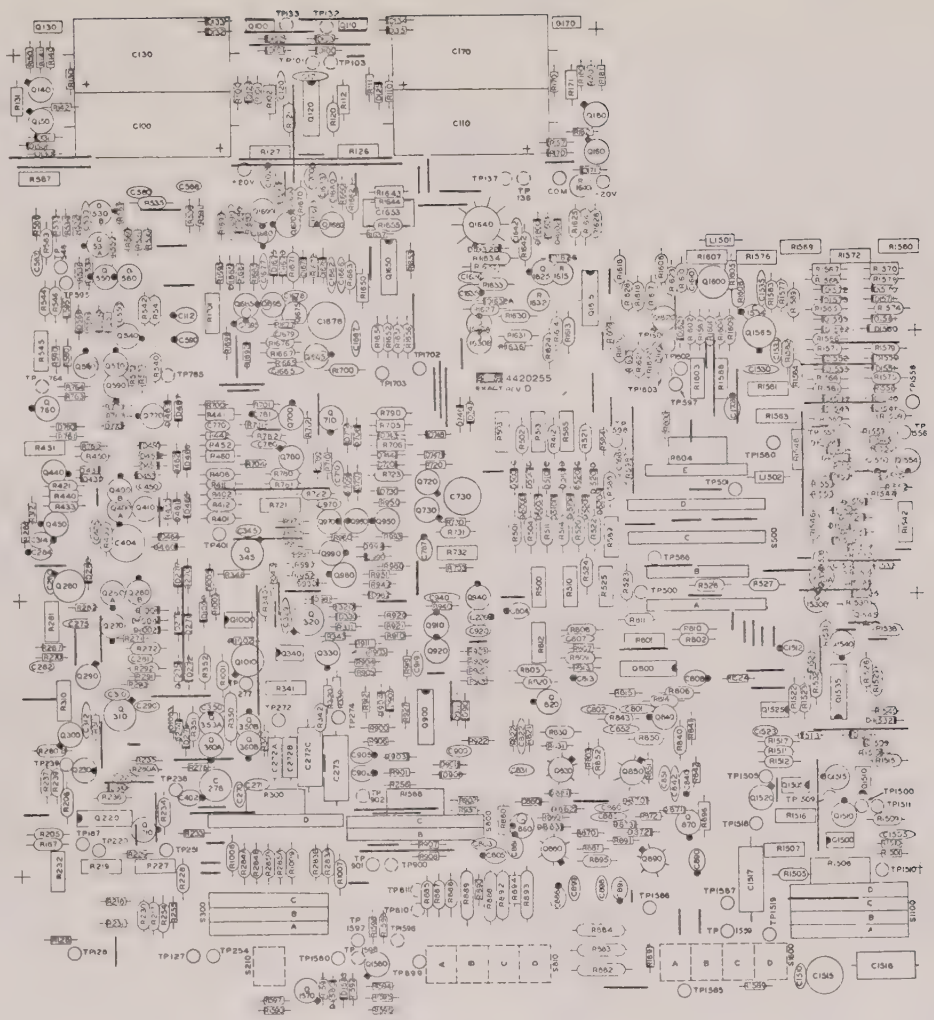
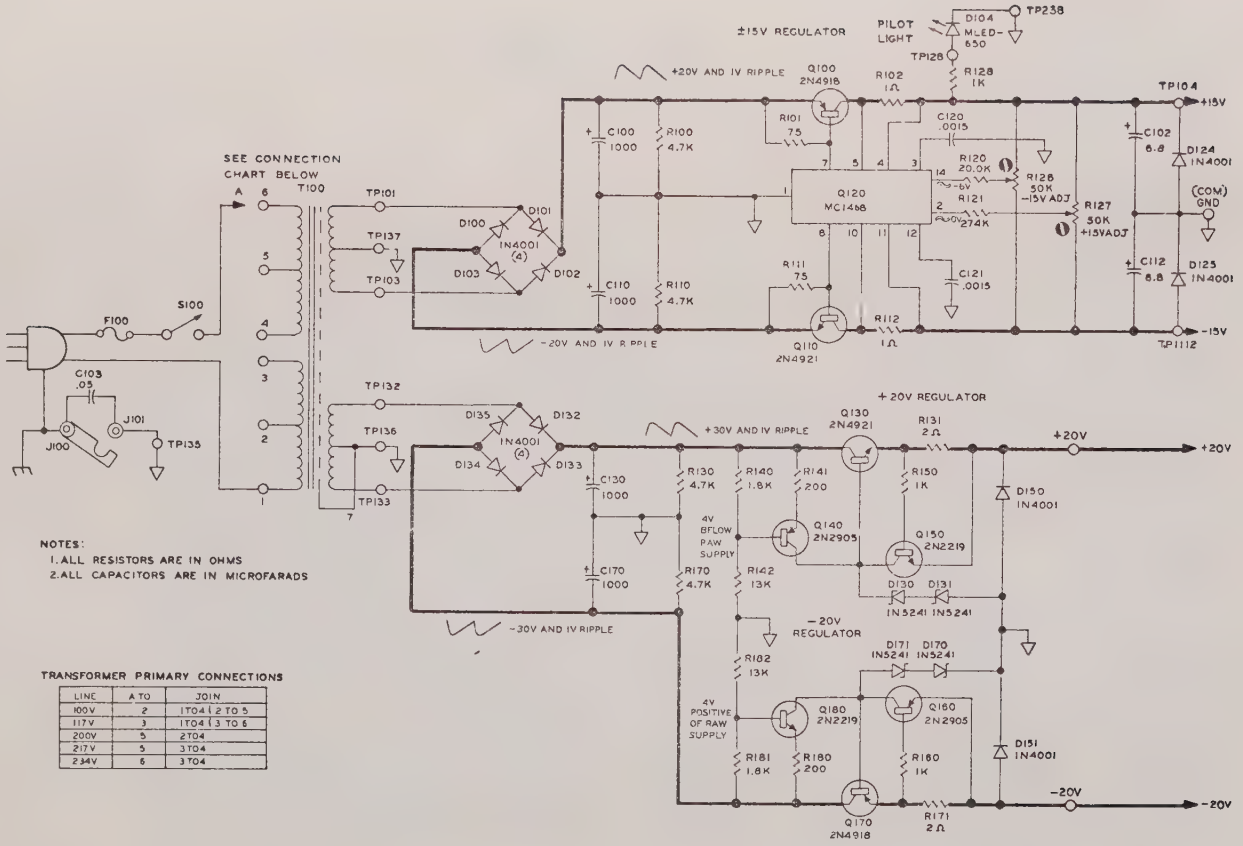


FIGURE 6.1.1
PARTS LAYOUT



NOTES:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

TRANSFORMER PRIMARY CONNECTIONS

LINE	A TO	JOIN
100V	2	1 TO 4 (2 TO 5
117V	3	1 TO 4 (3 TO 6
200V	5	2 TO 4
217V	5	3 TO 4
234V	6	3 TO 4

FIGURE 6.2.1
POWER SUPPLY CIRCUIT
(1)

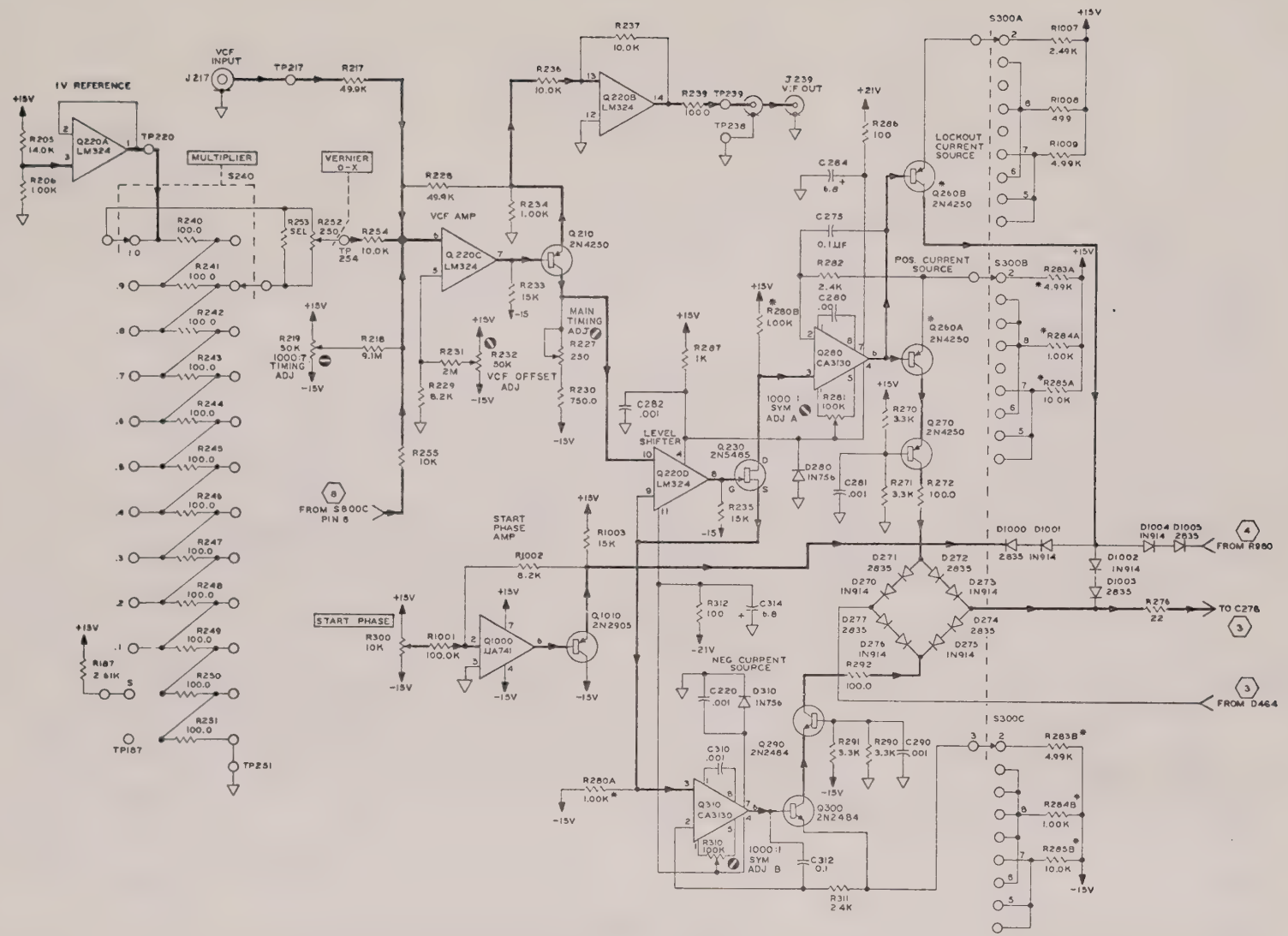


FIGURE 622

MAIN GENERATOR -

FREQUENCY CONTROL CIRCUITS

(2)

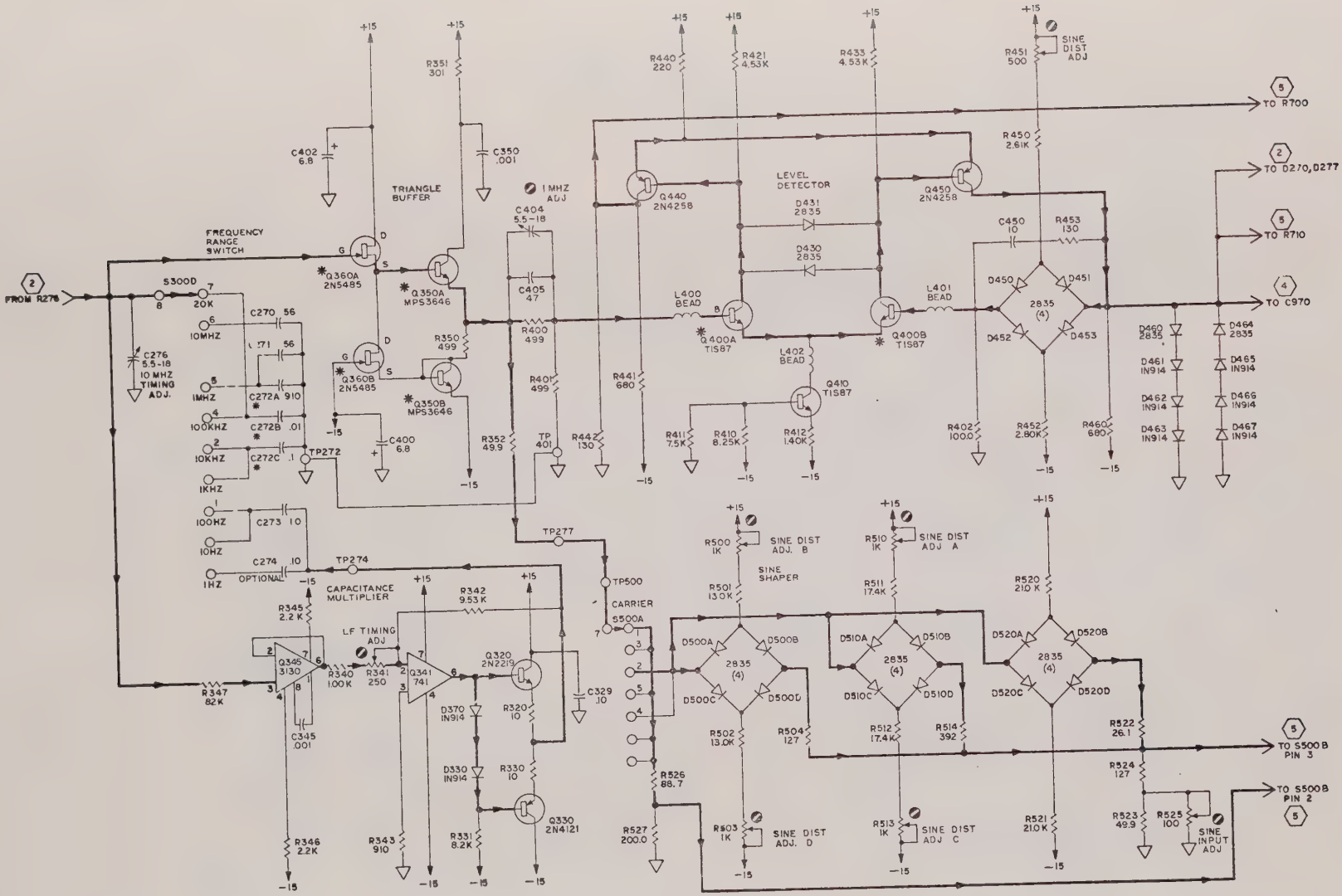


FIGURE 6.2.3
MAIN GENERATOR LOOP
AND SINE SHAPER CIRCUITS
(3)

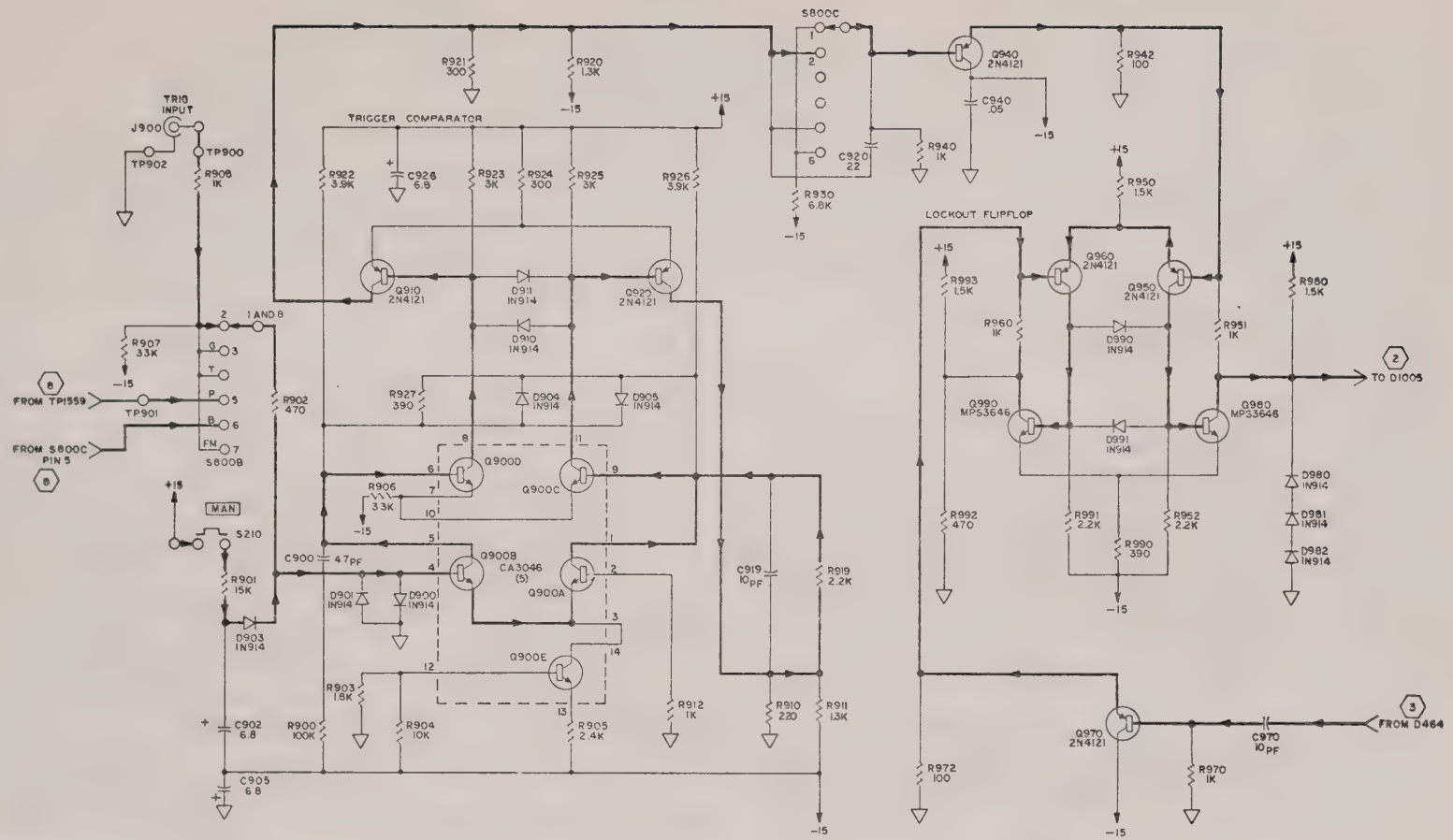


FIGURE 624
LOCKOUT CIRCUIT
(4)

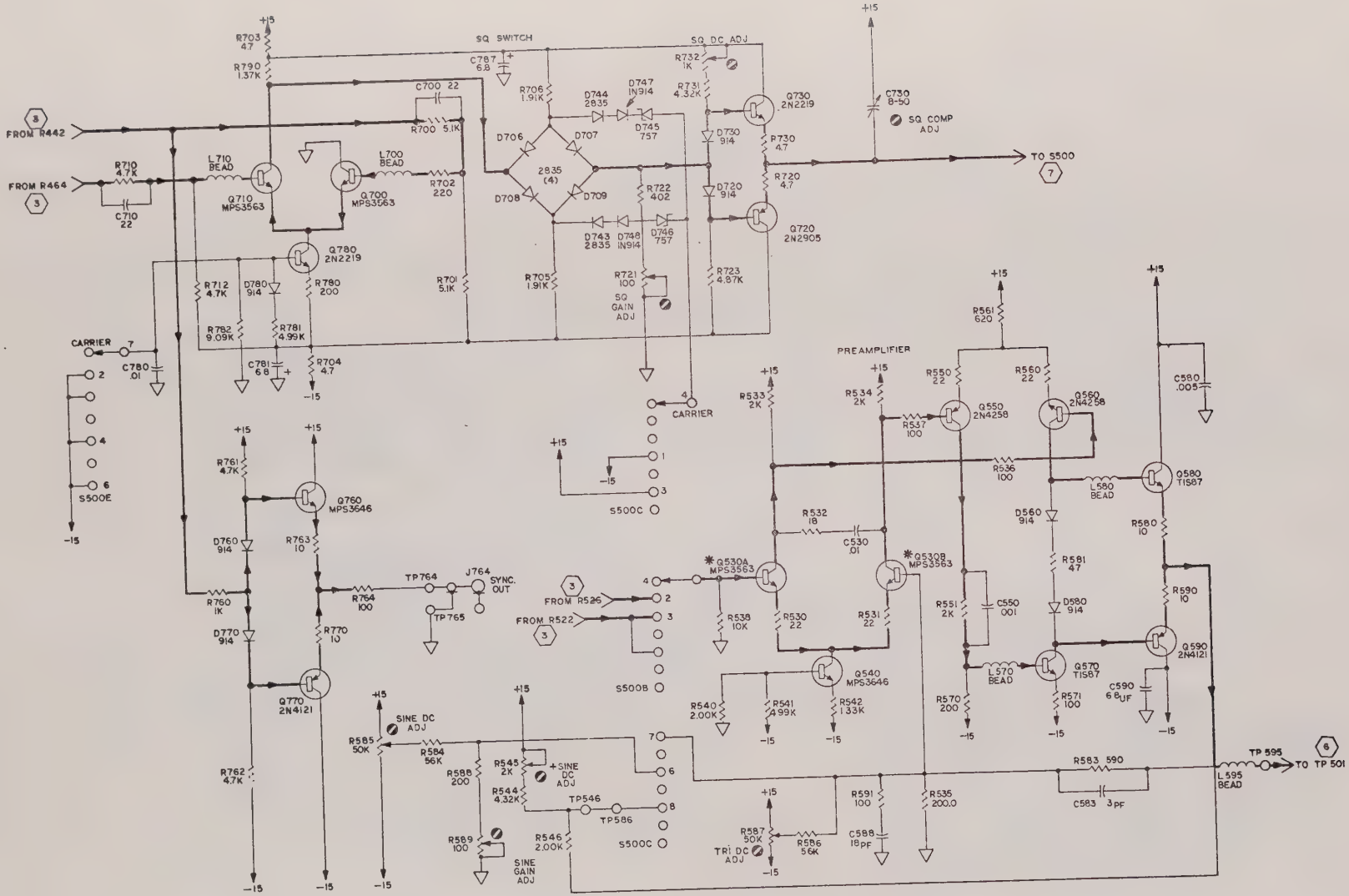


FIGURE 6.2.5

MAIN GENERATOR SIGNAL CONDITIONING CIRCUIT

(5)

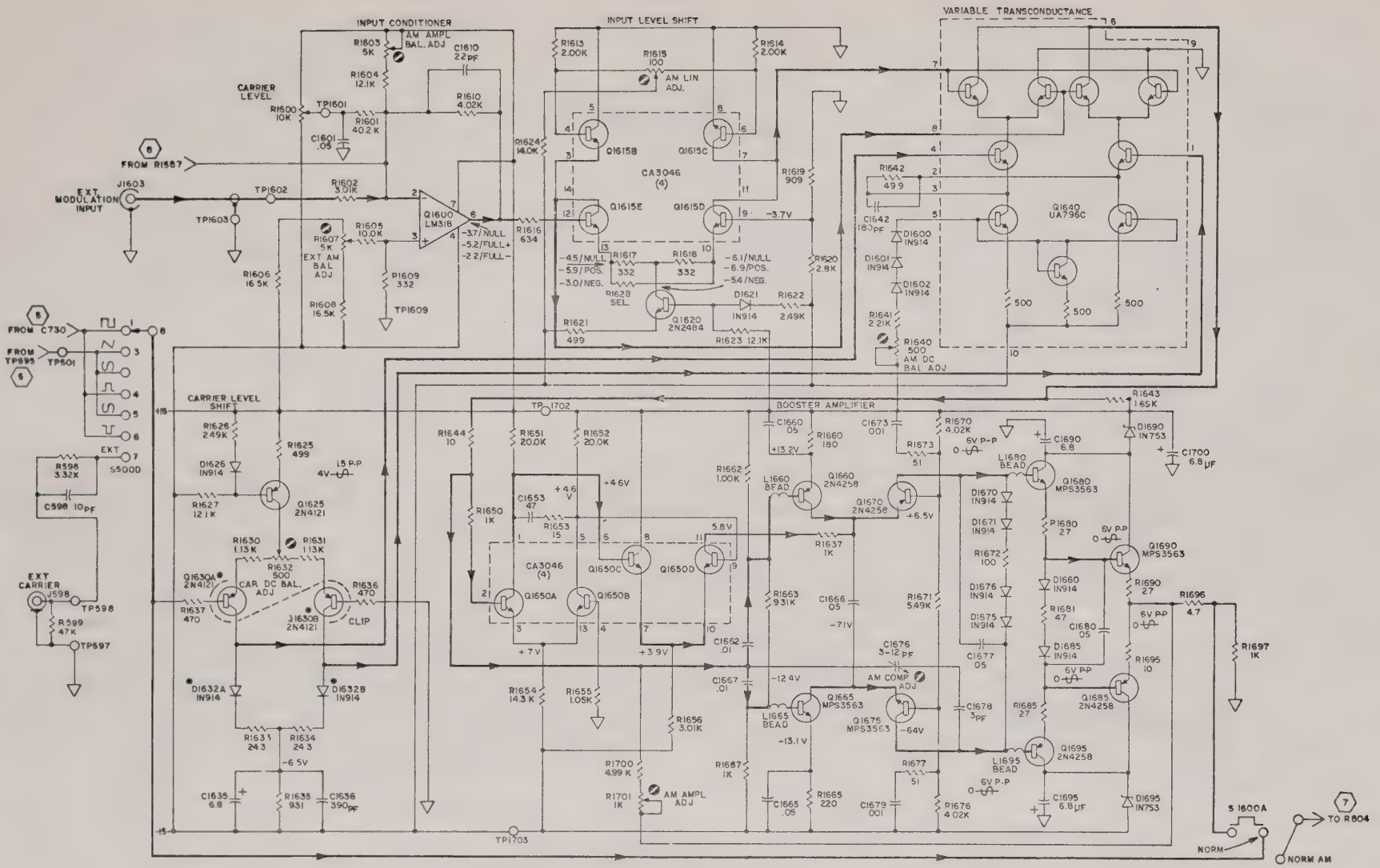


FIGURE 6.2.7

AMPLITUDE MODULATION CIRCUIT

6

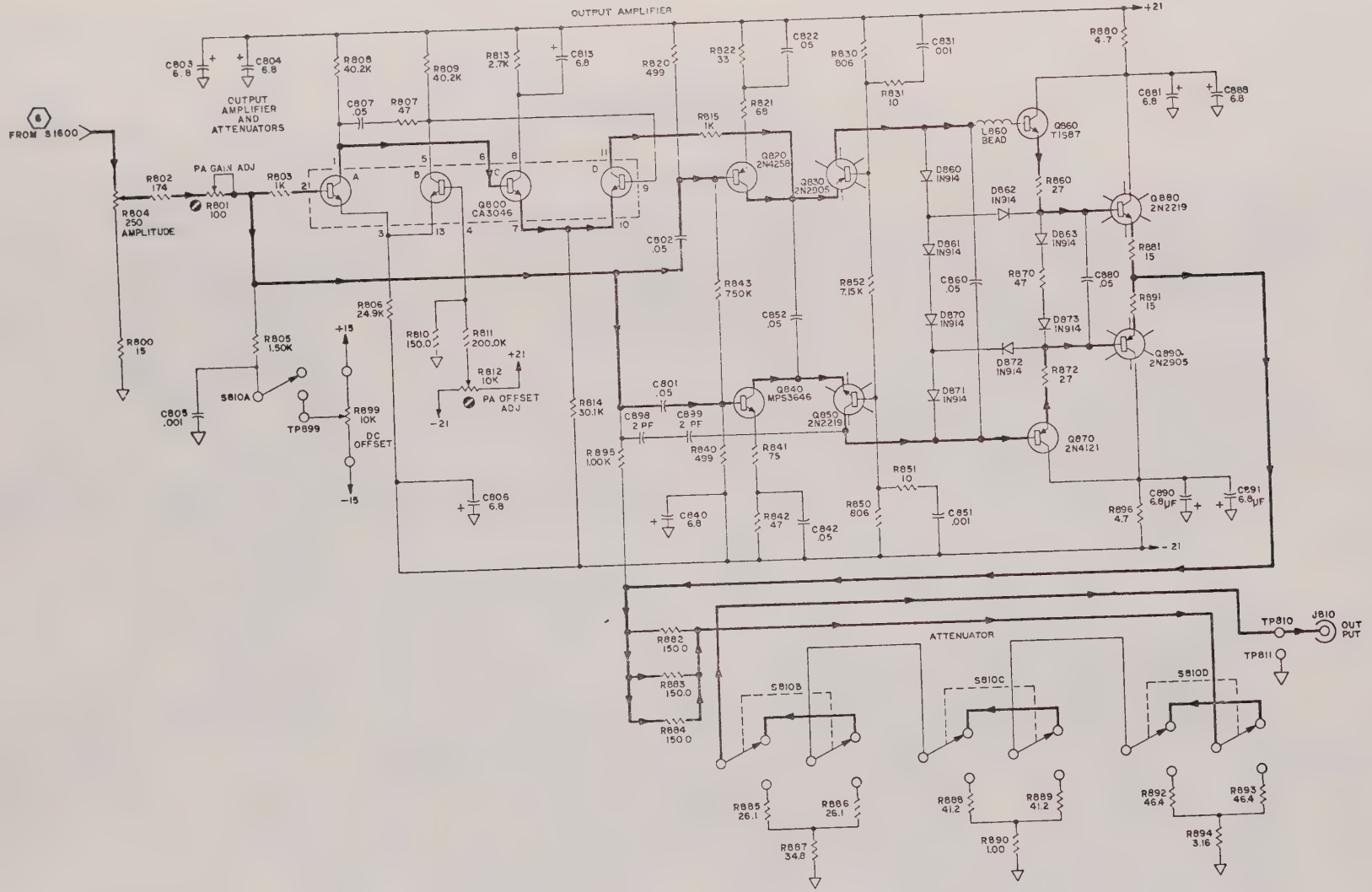


FIGURE 626
OUTPUT AMPLIFIER CIRCUIT
(7)

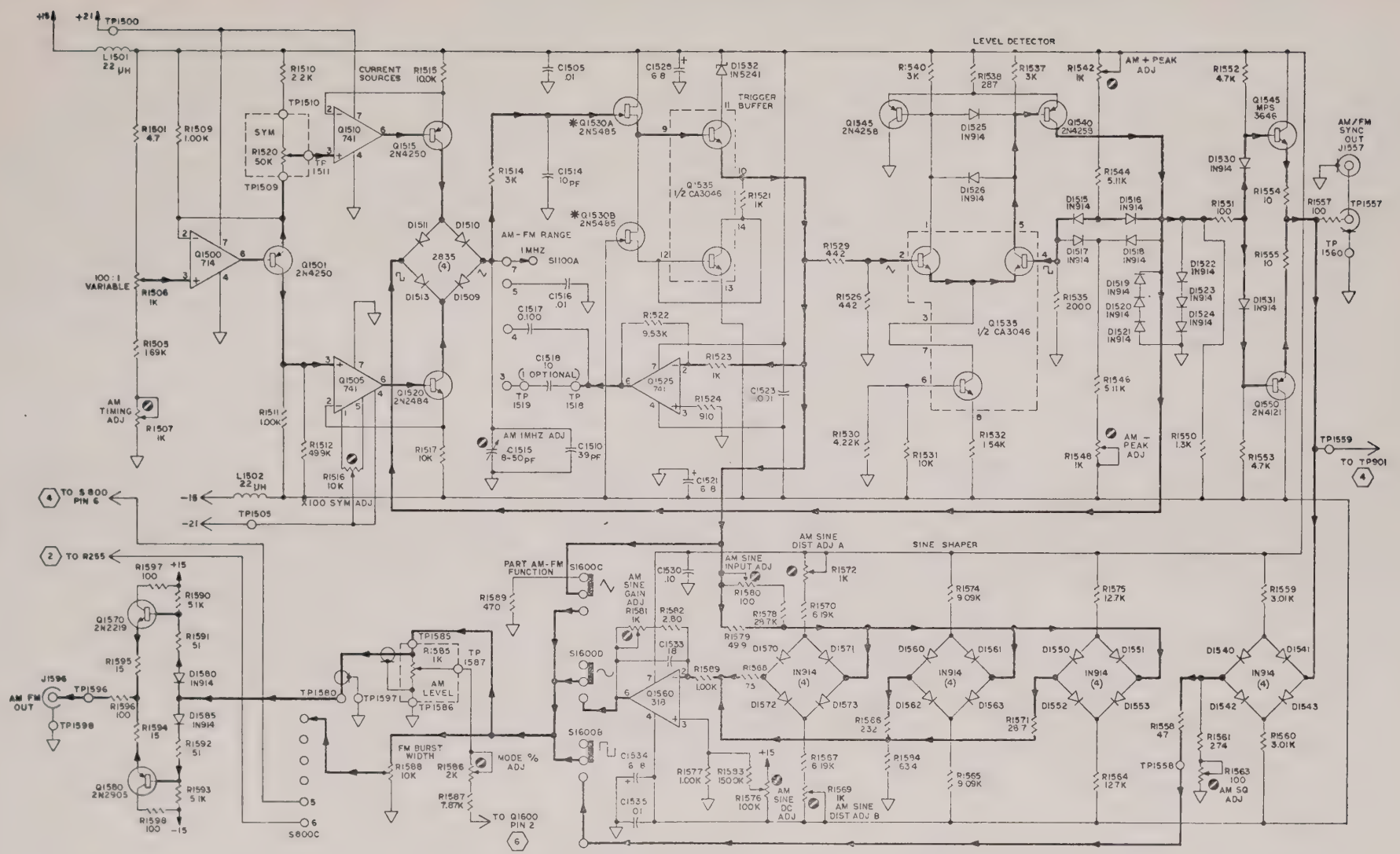


FIGURE 628
AMPLITUDE MODULATION
GENERATOR CIRCUIT
(8)

SECTION 7

ADDENDA

ADDENDA
Model 519

Schematic #3 Fig 6.2.3 p.59

R340	825 Ohm 1/4W 1% metal film	3138250
R320	100 Ohm 1/4W 5% carbon	3070101
R330	100 Ohm 1/4W 5% carbon	3070101

Schematic #5 Fig 6.2.5 p.63

Change 7 to 6 .

R524	110 Ohm 1/4W 1%	3131100
R588	150 Ohm 1/4W 1%	3131500
Q560	is a PNP	

.01 pf cap (cer) 2830005 added from collector of Q720 to ground.
.01 pf cap (cer) 2830005 added from collector of Q730 to ground.

Schematic #6 Fig 6.2.7 p.65

.01 pf cap (cer) 2830005 added to +15V supply from TP1702 to ground.
.01 pf cap (cer) 2830005 added to -15V supply from TP1703 to ground.
Delete D1600, D1602, D1606 and replace with jumper from R1641 to pin 5 of Q1640

R1640	2 KOhm (cermet) trim pot	3110348
R1641	13.7 KOhm 1/4W 1%	3131372
R1643	801 KOhm 1/4W 1%	3138013
Q1600	1CLM318	1580318

Schematic #7 Fig 6.2.6 p.67

R814	3.01 KOhm 1/4W 1%	3133011

Schematic #8 Fig 6.2.8 p.69

Q1560	1CLM318	1580318
R1512	10 KOhm 1/4W 1% metal film	3131002
R1513	10 KOhm 1/4W 1% metal film	3131002
R1578	28.7 KOhm 1/4W 1% metal film	3132872

Calibration Procedures Sec. 4.0.1

1. p. 40, instruction 2.A should read: "...for a reading of - 0.0045 volts.
2. p. 40, Preliminary Control Setting RANGE should be changed from 10 KHz to 100 KHz.
3. p.42, instruction 15A should read: "Set the counter to read period and rotate to 100:1 variable fully CCW.

Adjustment Location Detail Fig 4.0.1, p.39 (also parts layout 6.1.1, p.53)

Q1565 changed to 1560

Parts List

On Page 48, R894 is missiong; should be Resistor, 3.16 ohm, Exact No. 3103160